ENGINEERING

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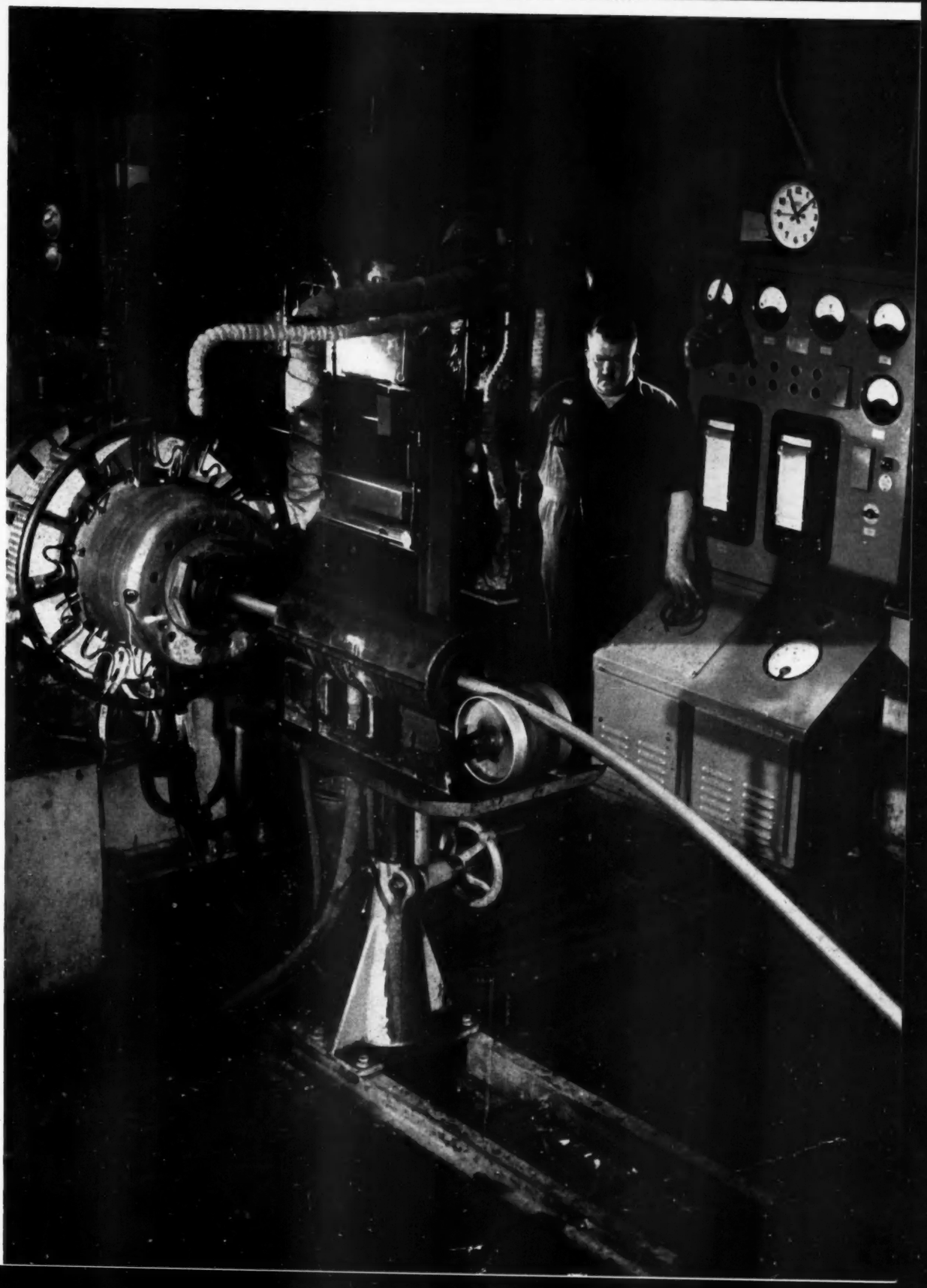
In this issue

Plant and Equipment
Research and Development
Design
Metals and Materials
Production
Construction
Marketing
Management

Atomic Review
Automobile Engineering
Engineering at Home
Companies in the News
Plain Words



PRICE
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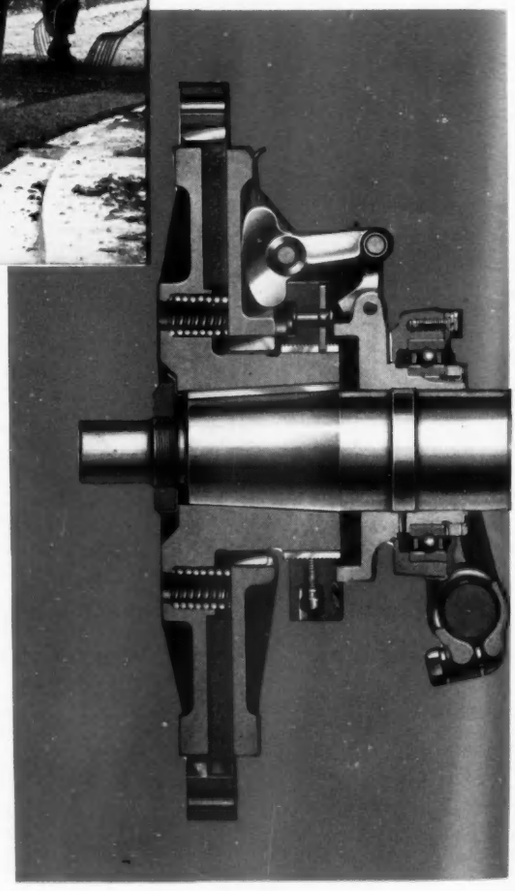
Sheathing a Cable



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Contents

1 **Leading Article**
Sons and Daughters

2 **Plain Words**

3 **Letters to the Editor**
Concrete Curing Tests

10 **Special Article**
Process Plant: The Chemical and Petroleum Engineering Exhibition

12 **In Parliament**

13 **Atomic Review**
Point Sequence

15 **Companies in the News**

27 **Book Review**
Handbook of Noise Control

27 **New Books and Trade Publications**

27 **On the Shelf**

32 **Engineering at Home**
Heating and Lighting
Thermal Storage Heaters on Trial
Hot Plate

Management

2 Weekly Survey
9 Standards Engineers: Their Education Training and Work
Productivity and Profitability Films

4 **Plant and Equipment**
Over-Riding Manual Control
Jig Borer
Vacuum Tube Voltmeter
Stabilising Ships' Electrical Supplies
More Powerful Marine Gas Turbine
Testing Large Ropes and Chains
Press-to-Test Warning Lamp
Pulling Power of a Tug
Regulating Valve
Hot Water Circulator
Fine Pole Magnetic Chuck
High Speed Electronic Counter
Portable Recorder
Separating Ore from Clay
Fixing Tools and Studs
Frequency Meter Tachometer

9 **Automobile Engineering**
Anti-Skid Unit for Automobiles

16 **The Human Element**

17 **Metals and Materials**
Bearings Keep Going Without Attention: PTFE Impregnated Bronze
Centenary of Bessemer Steel in Sweden

18 **Research and Development**
Talking to Americans: America is Still Going Places

23 **Marketing**

25 **Construction**
Self-Supporting Suspension Bridge at Samawa, Iraq
Britain's First Motorway
Side-Tipping Bucket for High Loaders
Adjustable Foundations

28 **Production**
Imperial Chemical Industries Titanium Plant in Wales

30 **Design**
Contour Squeeze Moulding
Single-Anode Rectifier to Withstand Vibration.

Sons and Daughters

THIS is the time of year when headmasters make their annual reports to parents. It also happens to be a time when famous Old Boys are opening new school science laboratories. Much of the money for new facilities for teaching mathematics, physics and chemistry has come from the Industrial Fund for the Advancement of Scientific Education in Schools, which has largely completed the task for which it was started. In less than three years the Fund has made a big impact on the teaching of science at school, the benefits of which will be progressively felt in industry.

The Fund was established in November, 1955, to give financial assistance by way of capital grants for building, expanding, modernising and equipping science buildings at the independent and direct-grant boys' and girls' schools. These are the schools which cannot receive assistance from public funds, as opposed to the maintained schools which are the concern of the Government and local education authorities. Altogether, 141 industrial firms subscribed £3,159,669, most of it by way of covenants, the last of which will be paid over in 1963. By October, 1957, this large sum had been committed. Some £2½ million had been set aside for new buildings at 201 schools, and another £360,000 for apparatus and equipment at 314 schools. Although the money is not paid over until the bills are presented, the Fund will have had to meet all its commitments with perhaps only half of the covenanted subscriptions received. A large charge has therefore to be met for interest on borrowing against future covenants. Nevertheless the Fund is closed so far as subscriptions are concerned.

When the active work of considering how to distribute the capital was commenced, a team of assessors was appointed. The assessors carried out what was perhaps the closest survey ever made of this important part of education. They found that, although the number of boys reading science was three times as great as in 1935, the accommodation for teaching had been increased hardly at all. In particular, they found an almost total absence of separate sixth form accommodation and of ancillary rooms. Equipment was often woefully short so that, at best, experiments could only be performed by boys working in large groups. At the girls' schools the conditions were even more dire, though they had not increased their science teaching to the same degree as for boys. In their effort to determine priorities the assessors compiled standards of facilities for teaching science and produced two admirable brochures, one concerned with buildings, the other with apparatus, listing the needs for schools. Emphasis was laid on teaching fundamental physics, chemistry, mathematics and geology (biology and the other basic sciences, in the interests of economy, had to be excluded except as part of general science teaching up to the Ordinary level of the General Certificate of Education). Moreover, although the need of the fund's sponsors was biased towards engineers rather than scientists, no contribution was made from the fund towards workshops for instruction; it was firmly believed that the schools should concentrate on the basic sciences. Help, however, has been given to provide workshops for masters, sixth formers and laboratory stewards to make equipment.

From the schools the organisers required evidence that they were trying to help themselves and that there was an adequate proportion of the boys doing science. Though perhaps less than one in ten of the head teachers had a scientific background, there were few who did not accept the national need for more and better educated scientists and engineers. Almost without exception they were ready to develop the teaching of physics and chemistry in their schools. The girls' schools have been treated as generously as the boys'. When all the building work is complete, there will have been a 50 per cent increase in the number of teaching places for science and in the area of teaching space for each student. In the schools concerned an increase of between 3,500 and 4,000 places (bringing the total to 16,000) has been made in sixth form science accommodation.

No one, least of all those contributing to the fund, believes that this campaign ends the problem of science teaching in the public schools. There is ample opportunity for individual companies of interest themselves in local claims, both of schools which were outside the fund's scheme as well as those that have received aid. The maintained schools, too, could frequently benefit by help from neighbouring industry, and enlightened local councils will not cut their grants because of outside help. Industry needs these boys—and girls—of high calibre, well grounded in the sciences. Urgent attention now has to be paid to absorbing these young people into industry fairly and effectively to the mutual profit of themselves, their employers and the country which nurtured them.

Cover Picture. *Many electric cables are sheathed in lead as a protection. The illustration shows such a cable, insulated with paper, having the lead sheath extruded round it. By this method of manufacture, long continuous lengths are possible.*
(*Nurnberg photograph for* ENGINEERING)

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Plain Words

Over the many years spent visiting concerns, I have enjoyed a remarkable degree of hospitality. Usually I have been received with cordiality. Occasionally I have worked doggedly through a meal to the accompaniment of embarrassing silences which felt eternal, or against a background of company business to which no stranger could adjust himself.

You know the kind of thing I mean. It takes various forms. Some dining rooms are presided over by silent, dominating chairmen or managing directors who do not so much take lunch as hold silent court. Some dining rooms are quite definitely given over to talking " shop " as a matter of policy because this is the only way that heads of departments can get together informally. In some cases, certain seats are sacred to certain people—and the fact is apt to be overlooked by someone bringing in a guest at the last minute. There are some companies where playing " intellectual " games of the quiz variety is a lunch-time ritual. These can be an acute source of embarrassment to the visitors since the odds are that he lacks the expertise of the hardened practitioners round the table and has to think hard, drop the odd polite word and cope with his soup at the same time.

There are variants on these forms of embarrassment. Some senior executives have an acute appreciation in a noisy way of their own sense of humour and mealtimes become a series of tedious anecdotes and would-be witticisms punctuated by a Greek chorus of appreciative smirks and giggles from the lesser fry. Another hazard for the visitor is where technical specialists eat (and hence converse) in packs. Many an engineer has had a miserable lunch trying to keep his end up among a group of experts in another field who would make no concessions to a stranger's limitations.

There are many places where the off-putting conversational gambit is practised. " You're an engineer," says the chief cashier, " built any good bridges lately ? " How do you avoid the pitfalls of a heavy, teutonic retort about specialisation in the professions or an allusion in bad taste to the un-taxed profits to be gained by tampering with the petty cash? Equally bad perhaps are the opening inanities such as: " Your name's Accles? I knew a man Accles from Birmingham. Any relation? "

There is scope for increased sensitivity and thoughtfulness for the visitor in most canteens and dining-rooms. Which reminds me: I had better circulate a copy of these Plain Words at lunchtime. We are not all that good ourselves.

CAPRICORN

Weekly Survey

Hydraulic Coal Mining

The National Coal Board is to spend £40,000 over a six months period beginning at the end of this year on pit trials for hydraulic mining. The experiment is to be carried out at a drift mine in Glamorgan. This project follows the board's interest in the hydraulic transport of coal in pipe lines. At a colliery in Scotland coal is being pumped up a vertical shaft and at one in Derbyshire lump coal is being hauled through a 1,000 ft pipe to the surface.

Hydraulic mining is used extensively in Russia and also in Poland and New Zealand. It gives a high rate of output per manshift, equipment is easy to operate and there is no explosive danger. The coal is extracted by the power of high velocity water jets directed at the coal seam. When the coal has been broken down, the water jet is used to clear the floor of the working space and to drive the coal to the point of collection. In the initial trials in Wales, coal will flow from the face into an open channel and be carried to a screen where all sizes above 2 mm will be separated and transferred to the normal conveyor belt system. The remaining slurry will be pumped up a 6 in diameter pipe to the surface of the drift mine where the fine coal will be removed and the clarified water returned to the system. If the trials prove successful steps will be taken to pump lump coal through the pipeline to the surface.

At the mine chosen, the room and pillar system is in operation. The drift goes down a gradient and meets a deep mine coal seam. The hydraulic mining will begin on the pillars, starting from the highest point and working backwards down the slope towards pit bottom. It has been estimated that water pressure of 600 lb per sq. in will be sufficient to break down the softer coal, and pressures up to 1,200 lb will be used for the hard and denser coals.

Spare Capacity

Not everybody accepted the Chancellor of the Exchequer's view at the time of the Budget that investment in the economy during the fiscal year 1958–59 would remain stable. Hindsight is, of course, always cheap but there are indications that spare capacity is developing in industry. The latest confirmation of this comes from the second industrial survey undertaken by the Federation of British Industries. In 76 per cent of the 554 firms replying, the present level of output is said to be below capacity. It has been apparent for some time that many sections of the industry have been reducing output and even turning off workers. To that extent the FBI's survey only confirms what all but the extreme optimists had known to be a new trend.

Too much can be read into the figures, however. There could be endless argument as to what is meant by " capacity " and what it really means to be considered to be operating below capacity. The word " capacity " is susceptible to various definitions and the Americans can often produce statistics in times of boom to show their steel industry is operating above capacity. The answers to the other questions broadly confirm the current view that order books are shorter and labour is easier to get. Of those answering 31 per cent felt less optimistic about the general business situation than three months before but this still left 68 per cent who were more optimistic or had not changed their views. Even when it comes to order books, 10 per cent reported them to be higher and 35 per cent the same. On the labour situation and capital expenditure the swing was probably more apparent. As many as 59 per cent were finding it easier to get labour and 50 per cent expected fewer authorisations on new building expenditure. Finally, 46 per cent expected smaller outlay on plant and machinery this year than last.

It is becoming increasingly apparent that the economy is being sustained to a remarkable extent by the boom in the motor-car industry and that any hope for a quick expansion of industry in the autumn depends on sustained outlay by the nationalised industries and the road building programme.

Financing British Railways

This week the annual report and accounts for the British Transport Commission have been published. The report indicates that the results for last year were " not far short of expectations." British Railways produced a working deficit of £27·1 million while there was a working surplus on other activities of £23·4 million. After allowing for interest and other central charges the Commission carried forward from its total operations a deficit of £63·5 million which exceeds " but not greatly " the deficit anticipated for the year under the Transport (Railway Finances) Act, 1957. The fact is, however, that the railways have increased their operating deficit owing to the increase in wages and this was not intended to be met in whole or in part in the plan put forward for the modernisation of the railways under the Act in question.

The report states that the first objective of the Commission in 1958, will be to improve the financial position of the railways. The prospects for higher revenue are not bright so the Commission will have to concentrate on reducing its operating expenses. The manpower position has significantly eased and further efforts are to be made this year to reduce manpower. The fact is that the Government's policy of deflation has made it possible for the railways to fill a larger number of vacancies and the problem for the future, so far as employment is concerned, will be to make economies rather than stimulate recruitment.

Among its other activities the Docks and Inland Waterways produced a surplus of £2 million although the Inland Waterways were operating at a small deficit. It is of interest that freight rates kept at low levels by statute resulted in heavy losses from the fish docks in eastern England. Among the rest of its activities only the restaurant cars on the trains yielded a deficit. Even the much criticised refreshment rooms made £½ million profit.

Since the year ended there have been two major developments to complicate further the prospects of the Commission. It has temporarily made its peace with the railway unions for an increase of wages of about 3 per cent, but there is every prospect of a renewed demand in the autumn. This year, too, it will have to carry the cost of the London bus strike.

Oil Threatens Coal

The ending of coal rationing has given rise to some concern in respect of the National Coal Board's price policy. The National Union of Mineworkers have been pressing for restrictions on the consumption of oil in industry and are developing a campaign to secure their objectives. There is deep uneasiness in union circles concerning employment in the coal mines during the next few months, which will not be made any less by the report of a private meeting between Lord Mills and the Conservative back-benchers' fuel and power committee.

Lord Mills told the committee that he had no intention whatever of allowing anything to vitiate the present powerful competition between

coal and oil. He was said to have accepted the arguments of Mr. Gerald Nabarro, vice-chairman of the committee, who considered that a world surplus of oil and large stocks of coal available at British pits were the only possible guarantee of stable prices and the only way to knock efficiency into the National Coal Board. Lord Mills also indicated that the "gentleman's agreement" between the Ministry and the Board was not ended by de-rationing and that the Board would not be able to raise the pithead price of coal without consulting him. In the present circumstances he could see no justification for a change in the price structure.

There is every likelihood, however, that the Ministry of Power's wings will be severely clipped in the near future. The Select Committee on Estimates reporting last week, put forward proposals for reducing the size and work of the Ministry. After calling attention to the scope for economies which the ending of coal rationing will bring, they suggest that the role of the Ministry should be reconsidered.

Using Coal to Best Advantage

During 1957, the British Coal Utilisation Research Association continued its basic research programme into the chemical grounds for the plastic softening of coals with a view to getting better control of coking properties. Work was also done on the establishment of the absolute significance of measurements of surface areas of coal and carbonised coal by the heat of wetting method and also into the solvent extraction of medium-rank coal with tar oils. Knowledge obtained in the past on the capillary structure of coke and chars has led the United Kingdom Atomic Energy Authority to place a contract with the association for studies into fundamental aspects of the reactivity of graphite towards oxidising gases.

The annual report for last year also covers the applied research programme of the association. A programme of research into small-pipe, force-circulation central heating was completed. This followed work done for the association's domestic laboratories and is claimed to be a large contribution towards the better use of solid fuel in the home. Successful work has also been carried out on the free standing convector fire with a restricted throat. A handbook is to be issued on measuring grit and dust emitted from chimneys—an important achievement for putting the new Clean Air Act into operation.

In the boiler department increasing attention is now being given to the automatic control of firing appliances. The need to increase the use of small coal has stimulated work on improving the performance of mechanical firing equipment for industrial boilers. Other work on boilers has included tests at a number of power stations to evaluate means for stopping corrosion in boilers due to condensation of acid. On gasification research a slagging gasifier using 200 lb of fuel per hour has been erected and studies are being made on slag behaviour as part of the programme of research into the possibilities of obtaining fuel or synthesis gas from low-rank coal in gasifiers operating at high pressures and temperatures where the ash is in the form of liquid slag.

Inflation Cut Down to Size

Everyone who has worked his way through the economic text books sooner or later reaches a point when theories no longer fit experience. This seems to have happened to the group which has produced the United Nations World Economic Survey study on inflation. Instead of putting up the old gambit about inflation being a condition of excess demand for everything, the survey says that recent price increases in industrial countries have been due to "certain structural characteristics of the economy."

Prices and wages are determined not only by supply and demand but by such modern refinements as conventional pricing formulae, government regulations, and collective bargaining agreements. And the links forged between prices and wages by these arrangements are frequently stronger than the action of supply and demand. In the words of the report: "because of these interlocking relationships any demand or supply factor tending to raise prices or wages in important markets, or any independent move by a major income-earning group to raise its earnings, may easily touch off a chain reaction leading to a cumulative wage-price spiral."

In these conditions Government policies to check inflation may secure price stability only at the expense of slowing down economic activity. Anti-inflationary policies, says the report, must take account of the differences between one inflation and another. The great inflations of the past have been brought about by a shortage of consumer goods in relation to private incomes. The inflationary experience of industrial countries over the past few years was not due to this cause. It contains three main elements. As demand increased specific bottlenecks appeared in the metal and metal-using industries with consequent increases in price. These increases in turn forced up the general level of prices. Further pressure was supplied by wage increases in dynamic industries during the upswing spreading to the rest of the economy. In other words rises based on increased productivity got passed on to industries where no such increase was taking place. Finally factors, the timing of which was almost accidental, such as the rise in the cost of living due to the Rent Act, have given an extra push to wage demands and new momentum to the wage-price spiral.

Perhaps the most important issue raised by the survey relates to the implications of restrictive credit policies for long-term growth. Attempts to secure price stability through cutting down demand may if carried too far actually bring any advance in economic activity to a standstill. In other words credit policy is a very blunt instrument and anybody who claims to forecast the exact effect of any change in interest rates is either an optimist or a novice.

Germans Call for Second View

The production of television sets in Germany increased from just under 600,000 in 1956 to 808,000 last year. Of these nearly 180,000 were exported. The number of television licences is now shooting ahead. Last October it passed the million mark for the first time, by March this year it was nearing one and a half millions. The spur behind this activity is the expected early expansion of the television network and of the hours during which programmes are shown.

The sort of arguments that raged in Britain before the ITA was set up, are now heard all over Western Germany. Government circles are still divided on how the second programme is to be organised, but there is wide popular support for breaking the monopoly of the Nord-West Deutsche Rundfunk. With Dr. Erhard's well known preference for private enterprise and the desire of industry and commerce for a new advertising medium the odds are on commercial television getting the prize. Nevertheless the religious bodies and other opposing groups are prepared to fight hard and it is probable that some sort of controlling body charged with maintaining standards will be built into the system.

Meanwhile Dr. Erhard has not failed to draw a moral from the situation. To the producers of textiles and other goods whose sales have slumped he has pointed out that their misfortunes do not show a fall in purchasing power, on the contrary they demonstrate the increased ability of the public to buy consumer durable goods such as television sets.

Letters to the Editor

CONCRETE CURING TESTS

SIR, The delay in answering Mr. T. N. W. Akroyd's letter published in your issue of 23 May (p. 666), occasioned by our absence abroad, is regretted. His comments on our article (ENGRG., 21 Feb., '58, p. 243) are of great interest. May we comment as follows:

(1) He states that there are three methods of accelerated curing, namely, steam curing, oven heating and boiling water heating. In essence, the essential requirement is the introduction of heat so as to hasten the chemical actions involved in curing, without so modifying these reactions as to change the end result and, at the same time, to ensure a constant relationship between the accelerated cured strengths and the normal cured strengths. There are other methods of introducing heat into concrete samples, of which two are v.h.f. induction heating and electrical resistance heating.

The three methods mentioned by Mr. Akroyd, however, have so far proved to be the most convenient but, of course, we are still in the early stages of this type of work.

(2) We agree most strongly that a well-designed electric oven is essential if oven heating is used. In time, it may prove possible to specify the oven performance fairly closely, so as to minimise differences between the performance of different ovens. In time, also, the advantages and disadvantages of various heating techniques will become apparent and, to this end, if the interest that has been displayed in the use of accelerated curing tests leads to more engineers using them, the publication of results will be most helpful.

(3) It appears that some misunderstanding may have arisen regarding our contribution on the maturity-strength relationship. In the first place, as was stated in our article, the maturity law we suggested applies only to concrete cured continuously at 185° F in an oven. Thus, with a known 28-day strength, one can select from the curves in Fig. 6 of our paper the appropriate values of A and B. Using the formula

$$\text{Percentage of 28-day strength} = A + B \log_{10} \frac{\text{Maturity}}{1000}$$

one can calculate the strength of the concrete, if it is cured at 185° F, for any length of time within the limits indicated. If the time were six hours, the relationship would be that shown in the curves in Fig. 3 of our paper. The 7-day strength could then be derived from this figure. As we stated, the law cannot be taken to apply to normally cured concrete, or to concrete cured partly by accelerated methods and partly normally, so that one cannot derive the normally cured 7-day strength from a known 28-day strength by the application of our law.

In general, the relationships between the 7 and 28-day strengths given in our paper are actual, i.e., six cubes were taken from each sample, two tested at a few hours old, two at 7 days and two at 28 days. That these relationships do not agree with those suggested in Road Note 4 was noted and may well be due to the reasons Mr. Akroyd suggests.

We do agree with Mr. Akroyd that the maturity law we derived is of no direct interest in the field of accelerated curing tests. It was derived out of general interest in the larger question of strength-maturity relationships.

(4) We hold no particular brief for compression testing machines with proving rings. The design and performance of testing machines is a highly specialised subject on which we hesitate to express an opinion, especially as opinions among experts appear to differ. We rely on using a well designed machine made by a reputable manufacturer and have so far found no reason to doubt its accuracy.

Yours faithfully,

N. G. BONDRE

N. N. B. ORDMAN.

Port of London Authority.

25 June, 1958.

Plant and Equipment

OVER-RIDING MANUAL CONTROL

It is sometimes necessary for a solenoid-operated fluid power control valve to be actuated when the electrical supply is not available; for example, when there is a supply failure, or during installation and testing of equipment. To meet this demand, Baldwin Instrument Company Limited, Brooklands Works, Dartford, Kent, have produced a mechanism for providing an over-riding manual control. It can be actuated by pushing a large knob with the palm of the hand. A standard 0·5 in bore four-way solenoid-operated control valve fitted with such a control is shown in the illustration.

Operation is by means of a shaft that enters through the end cover of the vavle and makes contact with the pilot piston head, which in turn is connected to the spool. When the over-ride shaft is depressed, it moves the spool from the "normal" to the "operated" position. The spool can be locked into the operated position by rotating the over-ride shaft when it is fully depressed, whereupon a D-shaped collar on the shaft locates behind the head of a locking screw. The locking position is positively indexed to ensure that the mechanism remains firm in the presence of vibration. To prevent the knob moving out with the normal operation of the spool, the shaft is not actually fixed to the spool, but only rests against it. At present the over-ride feature is available as standard on the company's 0·25 in and 0·5 in bore control valves only. In addition to being used on solenoid valves, it can also be used on pilot operated valves.

The solenoid-operated valve can be actuated manually by pushing the large knob with the palm of the hand.

JIG BORER *Small Machine for Toolroom or Production*

Designed for toolroom work or light production boring, the latest addition to the range of jig boring machines made by the Newall Engineering Company Limited, Old Fletton, Peterborough, has a Nitralloy spindle with a No. 2 Morse taper, running in a quill 3½ in diameter. It has a table 15 in by 20 in, which can be traversed 15½ in longitudinally and 10½ in across the bed. There is a vertical traverse of 5 in on the quill.

Spindle drive is from a three-speed a.c. motor through a four-speed gearbox, giving 12 speeds in the range 67 to 3,000 r.p.m. An electro-magnetic brake, operated automatically by the "stop" push-button, brings the spindle rapidly to a standstill, and holds it for tool changing. Pressing the "start" button releases the brake again, and means are provided for rotating the spindle by hand for clocking purposes. Coarse and fine feeds to the spindle are obtained by handwheels on the feed box, and there are three up and down power feeds, 0·0015 in, 0·003 in, and 0·006 in per spindle revolution.

Table location is by the Newall patented system of linear measurement. This consists of hardened, ground and lapped rollers, which act as the main 1 in gauging members, and are housed in the required trains in precision ground channels between the ways of the longitudinal and cross slides. A microlocator used in conjunction with the rollers is divided into 0·0001 in units and serves to provide the final fine adjustment.

MINIATURISED CABLE

British Insulated Callender's Cables Limited, 51-53 Hatton Garden, London, E.C.1, have introduced a new range of coaxial radio-frequency cables with overall diameters of less than 0·1 in. A typical example has an inner conductor of 1/0·0214 in silver-plated copper-covered steel wire insulated with solid polythene, plain copper-wire braided and nylon sheathed to an overall nominal diameter of 0·068 in. An alternative sheath of black high density Polythene is also available. The cable has a characteristic impedance of 50 ohms and a capacitance at 1 kc/s of 30 pF/ft. Cables of similar construction but having a characteristic impedance of 75 ohms will be available shortly.

The company are also producing a range of equipment wire, having an insulation of flame-retarding polythene. This is particularly suitable for e.h.t. leads to cathode-ray tubes, say the company, where the fire risk from the use of conventional Polythene can prove hazardous.

VACUUM TUBE VOLTMETER

The vacuum tube voltmeter type TF 1300 is the latest addition to the range of voltmeters produced by Marconi Instruments Limited, St. Albans. There is no conventional chassis: all components are mounted on the rear of the sloping front panel, shown in the illustration, which hinges upwards for servicing. Valve-base wiring and preset controls for calibration are concealed behind a quick-release meter surround. Operational presets are accessible in a case-top recess, which is also used for lead stowage. The recess-lid hinges back to form a support that allows the instrument to be used, if required, in a sloping position.

Alternating voltages between 0·1 and 100 volts can be measured at frequencies between 20 and 300 Mc/s. Direct voltages up to 300 volts, and resistances up to 5 megohms can also be measured. Only one zero setting is required for all voltage ranges.

Alternating current measurements are made with a lightweight cylindrical probe fitted with a non-slip p.v.c. sheath and safety guard. The rectified output from the probe is applied to one arm of a valve bridge comprising two double triodes; a second arm of the bridge is coupled to a splash-current balancing network including a potential divider across the high tension supply and a three-volt stabiliser element. The indicating meter is protected from overload.

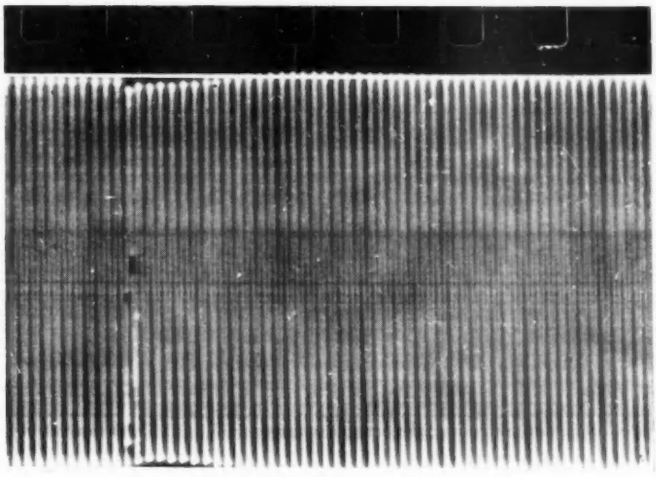
For direct current measurement, the input is applied directly to the bridge by means of d.c. leads the probe diode and splash-current network being automatically disconnected. For resistance measurement, the unknown resistor is connected, by means of the d.c. leads, in series with a standard resistor and the three-volt stabilised supply that is used for the splash current balancing in alternating current measurement. The meter responds to the voltage developed across the unknown resistor.

Continuing **Plant and Equipment**

STABILISING SHIPS' ELECTRICAL SUPPLIES

In ships with three-phase alternating current auxiliary services, the direct-to-line starting of large squirrel-cage motors may cause a considerable dip of system voltage. Careful design of alternators, and the use of main and pilot exciters in conjunction with automatic voltage regulators, provides sufficiently rapid recovery for tankers and other ships with little deck machinery, but for cargo vessels in general still closer regulation is desirable. This is particularly important in ships carrying passengers, where supply disturbances must be minimised because of their effect on "domestic" loads, such as lighting. When a ship is in port, numbers of motors may be in operation simultaneously and machines may be started at frequent intervals, each start representing a sudden application of load at a low lagging power factor, while two or more starts may occur within a small fraction of a second.

To meet these conditions the General Electric Company Limited has introduced the "Accurex" static excitation system for marine auxiliary alternators. The company claim that it combines fast and accurate voltage regulation with the advantages of having no moving parts and reducing the overall length of the generating sets. Replacement of rotary exciters by such a static system reduces maintenance and contributes to reliability. The reduction in length of engine-generator sets achieved by eliminating exciters may be of even greater importance in many installations. The components can be mounted on top of the alternator as a self-contained unit, but normally they are supplied in a form suitable for mounting on a switchboard panel remote from the alternator. In most installations the cost of the system is no more than that of conventional rotary exciters, and this type of regulator is applicable to sets with outputs up to the highest envisaged for marine auxiliary services. Equipments are in hand at present for sets with ratings up to 400 kW, to be installed in ships of various types including a number of tankers and a 10,000 ton dry cargo vessel which will be the first of its kind built in this country with an a.c. supply for all auxiliary services.



The effect on a small three-phase alternator with an "Accurex" system when half full-load current at zero power factor lagging is added to half full-load current at unity power factor is shown on the oscillogram.

A simplified circuit for one phase only, is given in the accompanying diagram. The alternator field is excited from the secondary of the current compounding transformer, CT, through the rectifier. Considering first the no-load condition, the terminal voltage of the alternator is applied across the saturable reactor SR, and a current lagging this voltage by about 90° will flow in the circuit formed by the reactor winding and primary A of the current compounding transformer, supplying the required no-load field excitation through the rectifier.

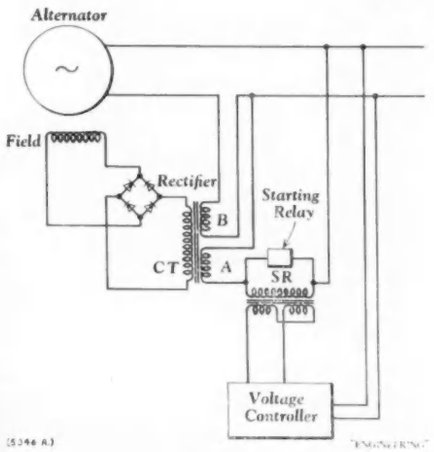
When the alternator is loaded, current passes through series coils B on the current compounding transformer. The secondary current of this transformer is then the vector sum of the reactor current and a current proportional to load current. As the load power factor falls, this resultant current and the alternator excitation are increased automatically, as seen in the vector diagram. Variations in alternator field resistance have little effect on the excitation current since they are swamped by the series impedance of the controlled reactor. The circuit also tends to be self-compensating for speed changes, since the reactor impedance falls with a drop in speed on account of the lower frequency.

It has been assumed so far that a constant excitation is applied to the direct current control winding of the saturable reactor. In practice, this excitation is taken from a magnetic amplifier fine control circuit and is adjusted automatically should the alternator voltage tend to change from its correct value. By varying the impedance of the alternating current winding, this results in adjustment of the alternator excitation so that correction is made for any inaccuracies in the self-excitation circuit and the alternator voltage is kept accurately constant under all conditions.

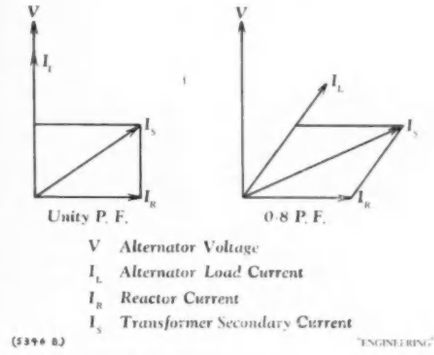
To ensure initial build-up of the alternator voltage from its residual value, a relay is included which shorts out the controlled reactor until the alternator voltage rises to about 50 per cent of normal.

The response of the "Accurex" system is assisted by the fact that both primaries of the current compounding transformer are current-driven, thus exercising a strong forcing effect on the alternator field. The machine flux is increased rapidly by the amount necessary to counteract the voltage drop caused by transient reactance when a load is applied. In this way the magnitude and duration of alternator voltage disturbances are kept to a minimum, and very heavy loads can be applied suddenly to the alternators without undue disturbance to other consumers fed from the same machines. An oscillogram is reproduced showing the effect on a small 3-phase, 415 V, alternator when half full-load current at zero power factor lagging is added to half full-load current at unity power factor. In this case the system restored the alternator voltage to within 1 per cent of the original value in 0·15 sec, after a maximum voltage dip of 5·3 per cent.

In the event of a short circuit, saturation of the static exciter components limits the excitation to about 1·5 times the full-load excitation, and the sustained short-circuit current will be about three times rated current. This characteristic facilitates the design of protective devices and ensures that a local fault will be tripped while maintaining the supply to other consumers. The "Accurex" system is applicable to any of the conventional systems of parallelling alternators.



A simplified circuit showing connections for one phase only.



The vector diagram shows the manner in which the alternator excitation increases with low power factor load.

MORE POWERFUL MARINE GAS TURBINE

A more powerful version of the Marine Proteus gas-turbine giving an increase 300 h.p., is now being developed by Bristol Aero-Engines Limited, Filton House, Bristol. The Marine Proteus 1260, as the engine is called, has a half-hour rating of 3,800 h.p.—compared with the 3,500 h.p. of the current version, the 1250, which is the power unit of the new Brave class of fast patrol boats now being built for the Royal Navy. Continuous rating of the new engines is 3,000 h.p. as against the 2,800 h.p. of the Marine Proteus 1250.

The increase in power has been obtained by using a slightly modified compressor which produces an increase in the engine's air mass flow. This improved compressor, which has been evolved as the result of intensive development carried out on the Proteus aircraft engine, will be fitted to all future production engines. In addition, the modifications have resulted in a small reduction in the engine's specific fuel consumption without any increase of severity in the operating conditions of the engine. Reliability and overhaul periods are thus unaffected.

Past experience with production engines has shown that the average weight is 2,885 lb, as compared with the design figure of 2,900 lb.

With the 300 h.p. increase in the half-hour rating, the Marine Proteus 1260 has an even more remarkable power/weight ratio than the earlier model—1·33 h.p. per lb bare dry weight.

Continuing **Plant and Equipment**

TESTING LARGE ROPES AND CHAINS

One of the functions of the National Coal Board's Central Engineering Establishment at Bretby, Burton-on-Trent, is to undertake the mechanical testing of mining machinery and equipment of all kinds.* New machinery installed recently for this purpose includes a 500 ton horizontal testing machine built by W. and T. Avery Limited, Soho Foundry, Birmingham, 40, and designed to accommodate wire and hemp ropes, chains and flat specimens up to 42 ft long. Grips and holders are provided to take wire ropes from 3½ to 10 in circumference, hemp ropes from 2 to 10 in circumference, chains from ⅞ to 2 in, and flat specimens from 1/16 to 1 in by 6 in. The machine has a stroke of 10 ft and two straining speeds, 0 to 1¼ in/min and 0 to 5¼ in/min. Return speed is 18 in/min.

There are four main units in the machine; a single-cylinder straining unit of 500 tons capacity, a twin-cylinder load-measuring unit, a load-indicating mechanism and a hydraulic pumping set.

Loads are applied by a double-acting hydraulic cylinder and ram at the extreme end of the machine, and a cross-head and a pair of side members or tension racks running on flanged rollers within the bed of the machine. The cylinder, a steel forging, is visible in the foreground of the first of the accompanying illustrations. It is secured to a fixed cross-head forming the end of the fabricated bed. Grip holders for specimens to be tested are connected to the straining head by means of shear pins engaging in holes in the tension racks; these holes are at 2 ft intervals, and give a range of adjustment to deal with specimens from 0 to 42 ft long, the full 10 ft stroke of the ram being available wherever the grips may be set. A recoil valve on the straining cylinder protects it from shock when a specimen breaks.

HYDRAULIC LOAD MEASUREMENT

At the opposite end of the machine from the straining cylinder are twin 12 in stroke hydraulic cylinders and rams, supported by a fixed cast iron cross head and connected to a second live cross-head which carries grip holders for specimens. Ball-ended loading struts transmit the load from the rams to the cross head, and provision is made for balancing the rams and struts to minimise friction. A recoil cylinder is fitted in the centre of the machine between the two measuring cylinders, and connected to them by a recoil cross-head and four tie bolts; these bolts also anchor the measuring cylinders to their support cross-head.

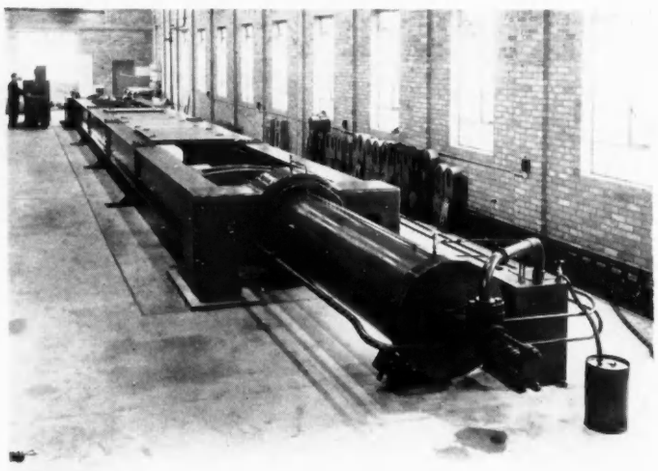
The rams in the measuring cylinders are ground to a close sliding fit with the cylinder necks to function without packing, and as there is no packing friction the pressure in the cylinders is a true measure of the load. It is possible to apply a load to the specimen through these cylinders, but their primary function is one of load measurement rather than load application.

LOAD INDICATION

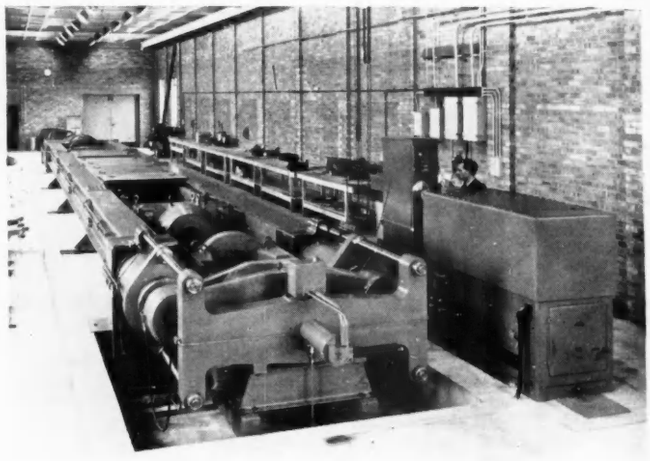
A pipe connection from the measuring cylinders to the load indicating mechanism adjacent to the cylinders enables the hydraulic pressure developed during testing to be transmitted to a small proportional cylinder, the ram of which is connected, by a lever system, to a pendulum weighing system and dial indicator. Loads are thus converted from pressures to weight units on the dial, which has four capacity ranges on a circular reading line 23 in diameter. Any one of the four ranges can be selected by means of a hand-wheel. The ranges are: 500 tons by 1 ton 250 tons by 0·5 ton, 100 tons by 0·2 ton, and 50 tons by 0·1 ton.

Load-measuring cylinders, load-indicating mechanism (being read by the operator), and the hydraulic pumping set are all visible in the second of the illustrations reproduced herewith. Hydraulic power is provided by two pumps, one large and one small, both operating at high pressure, and driven by a double-ended electric motor. There are also two small gear pumps for exhausting the leakage from the measuring cylinders. An oil tank is mounted above the pumps.

Close control of loading is provided by the valves, which are grouped at the front of the load-indicating mechanism cabinet. It is possible to set the valves to give a slow straining or adjusting speed of up to 1¼ in/min, and to direct the flow from the small pump, which provides this slow loading pressure, into the measuring cylinders for initial priming. For faster straining, or for setting at up to 5¼ in/min, the larger pump is brought into operation through the appropriate valve. Loading can be set to remain constant on an elastic specimen, and any load can be held for a long or short period by valve setting. Unloading can also be adjusted to the speed required. Load limiting pointers can be set to control the load automatically, or to hold it at a pre-determined value. An autographic recorder is fitted to produce load/extension graphs, and a time record can also be marked on the graph.



Loads up to 500 tons can be applied to chains, ropes and flat specimens on the Avery horizontal testing machine supplied to the National Coal Board.



The operator is seen here in the position from which the machine is controlled and the load readings are taken.

* The Establishment was described in ENGRG., vol. 182, 1956, p. 815.

PRESS-TO-TEST WARNING LAMP

The latest addition to the range of electrical components made by Dowty Nucleonics Limited, Brockhampton Park, Andoversford, Gloucestershire, is a compact warning lamp incorporating built-in facilities for dimming and lamp filament checking. Equally suitable for industrial or aircraft use, the lamp, which is shown in the accompanying illustration, is interchangeable with earlier electrical and electro-magnetic indicators; it can be installed from the front of the mounting panel and requires little space, its 1⅛ in overall diameter allowing a minimum centre-to-centre distance of ⅞ in.

When used as a "normally-off" warning indicator, the lamp filament can be checked simply by pressing the transparent plastics lens, lighting the lamp through auxiliary contacts. The small replaceable lamps are available for 6, 12 or 28 volt supplies, rated at 1 watt, and can be rapidly changed by unscrewing the front section of the unit.

The warning lamp is available with or without variable dimming which adjusts the amount of light transmitted through the lens to suit the ambient lighting conditions. The adjustment is made simply by rotating the lens bezel through 90°. Red, green, amber, blue and clear lenses are available.

The three screw-type terminals at the rear of the unit are protected by a rubber cover with individual cable holes. Internal seals effectively reduce the ingress of moisture and dirt, equipping the lamp for industrial use at ambient temperatures up to 50° C.

PULLING POWER OF A TUG

A simple adaptation of a standard machine has enabled W. J. Yarwood and Sons Limited, Northwich, Cheshire, to determine accurately the pulling power of a tug throughout the full range of engine power and speed, and so to check its designed performance. The machine is a crane weigher, made by Geo. Salter and Company Limited, West Bromwich, and the only adaptation necessary has been to fix it in a horizontal position to a small wheeled carriage for ease of movement. As can be seen from the accompanying illustration, the weigher, which has a capacity of 20 tons by 2 cwt divisions, is made fast on the quay side by means of its standard suspension shackle, and a steel hawser is run from the tug to the weigher load shackle.

As illustrated the weigher was determining the pull of the tug Martello, built for harbour and estuary service. The tug is fitted with a National four-stroke diesel engine developing 440 s.h.p. at 300 r.p.m. at the propeller. A maximum pull of 7 tons was indicated by the weigher, the vessel's free running speed being in excess of 9½ knots.

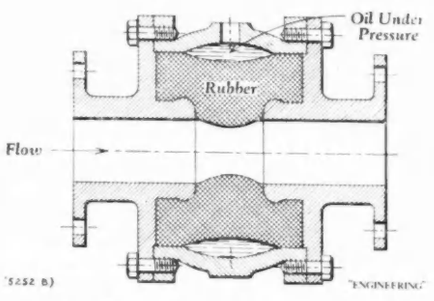
Salter crane weighers are used in a similar manner at Bantry, in south-west Ireland, but with a somewhat different object. Three 20 ton machines are in use there for determining the most efficient trawling speed of ships in the large Spanish fishing fleet which operates off the south-west coast of Ireland. Given the necessary information in the matter of pulling power, a vessel can tow its trawl at a speed regulated by the engine r.p.m.

A crane weigher measures the pull.

REGULATING VALVE

The Sala valve now being marketed in this country by Neldco Processes Limited, Percy Avenue, Ashford, Middlesex, is designed especially as a control valve giving a round hole down to a very small part of the full area and giving a Venturi flow pattern which results in very small friction losses. One model is shown in the accompanying illustration.

(Right) The Sala valve gives flow regulation with a virtually circular passage.



(Above) The closure element is a rubber moulding compressed by castor oil.

The closure consists of a heavy rubber moulding fitted into a cast iron casing. Pressure is applied to the space between the rubber and the casing by a hydraulic pump using castor oil as the fluid and this causes the rubber to contract inwards, thereby reducing the aperture which, however, remains virtually circular. The aperture is inversely proportional to the pressure applied, so that the pressure gauge can be calibrated to show the actual aperture size.

As the rubber moulding when compressed gives a slow lead-in to the constriction, there is no tendency for the drier slurries to build up and plug the opening. The adjustment of the passage diameter is controlled through a hydraulic pressure operator. The valve can be totally closed, but this is not recommended, except for short periods. Four sizes are made ranging from 1½ in to 4 in diameter.

FINE-POLE MAGNETIC CHUCK

To meet the demand for fine-pole magnetic chucks, particularly when associated with production grinding machines where maximum table loading of relatively small components is required, James Neill and Company (Sheffield) Limited, Sheffield, 11, are adding a range to their Eclipse products. The first model to be announced is Type FP 186, having a working surface of 18 in by 6 in. It is understood that similar chucks will shortly be available for table sizes of 24 in by 8 in as well as for 10 in and 12 in wide tables in any multiple lengths of 18 in.

The " inner " poles of the chuck extend from edge to edge with a castellated arrangement of the poles providing the major holding area in the centre. By the method of pole construction, the " outer " poles are linked together thus enabling magnetic flux from all magnets to be fed to a single workpiece placed anywhere on the chuck surface.

HOT WATER CIRCULATOR

Precision Electrical Products (Stockport) Limited, Progress Works, Cale Green, Stockport, have recently increased their range of circulator pumps by the addition of a small unit to be known as the Pepikin 25.

This new pump is designed for installation in ¾ in, 1 in and 1¼ in pipelines and has been introduced to meet the requirements of engineers interested in small circulator systems particularly in the field of low-pressure heating. The small size and weight of this new accelerator facilitates rapid installation since it can be fitted directly into new or existing systems either horizontally or vertically, no foundations or special fittings are required and pipe work is able to follow the most satisfactory route.

The circulator is of unit construction and has waterways which permit free gravity flow immediately the pump stops. The normal design has a close-grained cast iron body and a gunmetal impeller; the stainless steel shaft is supported in a self-lubricated combined radial and thrust bearing. The pump can also be supplied made from gunmetal throughout. The motor, which can be detached quickly without draining the system, is of the drip proof squirrel cage induction type.

HIGH SPEED ELECTRONIC COUNTER

A high-speed electronic counter which is capable of counting articles passing between the photocell and lighthead at the rate of up to 3,000 per minute, has recently been introduced by the Electronic Machine Company, Limited, Mayday Road, Thornton Heath, Surrey. Designated the " D.1," it employs a cold cathode Dekatron counting tube and cold cathode valves. The counting tube is used to record the units and an electromagnetic counter records the tens; the total number which the counter will accept before resetting to zero being 9,999,999. A reset device is fitted so that a new count can be commenced at any given time. The unit is suitable for dealing with very small objects as well as large ones.

PORTABLE RECORDER

A new lightweight battery-operated tape recorder for use in the field is now being marketed by Fonadek (Branson) Limited, Vivian Road, Harborne, Birmingham 17. This all-transistorised machine, called the Phonotrix, weighs 6¼ lb, and is fully portable. The twin-track recording tape provides for 70 minutes' recording time, and the four U2 (1·5 volt) batteries—which provide all the power that is needed—last for 50 hours. Controls include rapid rewind, automatic volume adjustment, and playback volume control. The recorder measures only 6½ in by 4¾ in by 3½ in, and can be used in its carrying case, which measures 10½ in by 5½ in by 3¾ in, and also houses the microphone and speaker.

Continuing **Plant and Equipment**

SEPARATING ORE FROM CLAY

The largest blade mill ever built at the Erith works of the General Electric Company Limited, is now in operation at the concentrating plant of the African Manganese Company Limited, Nsuta, Ghana, West Africa. Designed for disintegrating clay in crushed ore so that it can be washed out prior to concentration of the manganese, the mill has a capacity of 400 tons of minus 5 in ore per hour. For ease of transport overseas the mill, which weighs 80 tons, has been so designed that no single part weighs more than 10 tons.

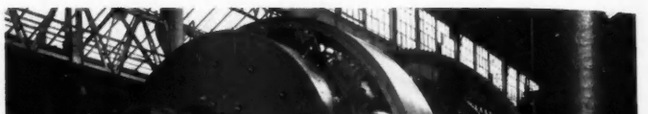
The mill consists, essentially, of an 8 ft diameter rotating cylinder, 24 ft long, supported on eight rollers. Ore enters through a feed inlet at one end with about an equal weight of water, and is so churned up by rows of blades during its passage through the mill that all the clay is disintegrated and the mineral is scrubbed clean by the time the ore reaches the discharge end of the mill.

The shell, which is of 1 in mild steel plate, is in two sections, each 12 ft long, and the two halves are joined by spigoted flanges, with four fitted bolts on the principal axis for accurate location. Chromium steel liners, 2 in thick, protect the interior of the shell, including the ends. Blades, cast integral with the longitudinal liners, give a tumbling and churning action to the ore and so break up the clay as it passes through the mill. At the discharge end radial scoops lift the disintegrated ore pulp on to a heavy central deflector of manganese steel, which passes it to a discharge trommel with circumferential blades for moving it forward out of the mill.

Two roller paths of cast steel, 4 in thick with 20 in faces, surround the shell. They are each mounted on 16 steel bars to allow slight springing under load, and to permit slow creep round the shell; this guards against deformation from continual harmonic vibration produced by the gear train at certain spots round the circumference. Each roller path runs on two pairs of 21 in diameter rollers, each pair being mounted on an adjustable rocker assembly. Two thrust rollers position the shell longitudinally.

A 12 in wide spur gear mounted round the shell takes the drive from a pinion, which, in turn, is driven through a flexible coupling, a 10 to 1 reduction gear and a Vulcan-Sinclair scoop-controlled fluid coupling, from a GEC 500 volt totally enclosed motor. Mill speed, which is infinitely variable through the coupling up to a maximum of 18 r.p.m., is generally kept within the range 14 to 18 r.p.m.

Guards, with Perspex windows, are provided for the gear wheel, pinion, roller tracks and rollers. Lubrication of the roller bearings on which the mill runs is by hand pump with piped connections to each of the 30 bearings.



Clay occuring with manganese ore is broken up and washed away in the GEC blade mill. Throughput is 400 tons per hour.

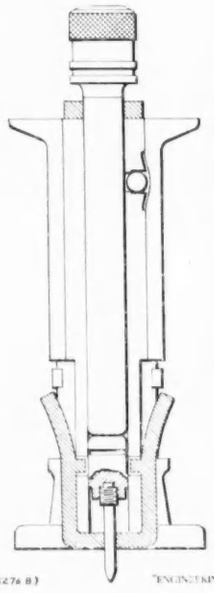
FIXING TOOLS AND STUDS

A simple and effective method for fixing parts to brickwork and concrete structures, the Hilti system, of Swiss manufacture, is now available in the United Kingdom. The marketing and servicing agents are Ucan Development Limited, Dome Buildings, The Quadrant, Richmond, Surrey.

As shown in the illustration below, an ordinary club hammer is used (2½-4 lb) in conjunction with a special tool designed to focus the full driving force of the hammer blow on to the hardened steel Hilti nail or stud. The latter are specially shaped with a " ballistic " point and a tapered shank which ensures a firm grip along the full length. The pull-out resistance of Hilti nails and studs, it is claimed, ranges from 500 to 1,400 lb according to the material and penetration.

The principle of the Hilti tool is shown in the illustration on the left. The nail or stud is guided at the head as well as at the point of penetration, preventing bending of the nail, and giving a cleaner entry with less damage around the fixing. The base plate holds the tool so that the driving force, transmitted to the stud by the plunger, is vertical to the surface being penetrated.

Hilti nails and studs are available for applications ranging from plastered and other light walls to reinforced concrete and channel iron. Among the forms in which they can be supplied are conic pins, threaded studs, ¼ in and $\frac{3}{32}$ Whitworth, and internal threaded bolts, ⅛ in Whitworth, all in a range of lengths. Special fixing tools are available for particular applications.



(5276 8) "ENGINEERING"

(Left) The nail, or stud, is guided at the head as well as at the point of penetration.

(Below) An ordinary club hammer is used in conjunction with the Hilti fixing tool.

MAKING STEAM

Unusual in its presentation is the film " Steam and Steam Generation " that has been produced by International Combustion Limited to aid recruiting. In full colour and with sound, the film shows the principles behind steam generation by experiments and models. The mysteries of " total heat " " sensible heat " and " latent heat " are clearly indicated by a series of graphs. Available in both 35 and 16 mm versions, the film runs for about 30 minutes. It can be obtained on loan from either International Combustion Limited, 19 Woburn Place, London, W.C.1, or from the Gaumont-British Scope Film Library, 11 Belgrave Road, London, S.W.1.

FREQUENCY METER TACHOMETER

A new tachometer has been produced by Racal Engineering Limited, Bracknell, Berkshire. It is the model MA.38 and is shown in the illustration. When used in conjunction with the Racal digital frequency meters types SA.20 or SA.21 it may be used for the direct reading of shaft speeds in the range between 100 and 20,000 r.p.m. The device consists of a rotor with 60 teeth turning in a magnetic field. Thus an output of 60 pulses is obtained for every complete revolution of the rotor. The output is fed to the frequency meter which can sample the input for one second and so give a direct indication of shaft speed in r.p.m. Apart from shaft speed the MA 38 may be used for any type of measurement which can be converted to rotary movement.

A pulse is generated by each of the 60 teeth on the rotor.

Management

STANDARDS ENGINEERS

Their Education, Training and Work

At the fourth conference of engineers responsible for standards, held recently in London, emphasis was laid on the increasingly important function of standards in international trade (as reported in last week's issue, p. 798). In addition, the complementary questions of education and training in standards work, and the responsibilities of the trained standards engineer in industry, were also discussed.

It was reported that, following the last conference, the I.Prod.E./BSI committee had considered further the content of training courses. Agreement had been reached on the three following general principles: (*a*) All engineering students should have general instruction on the various types of standards such as those dealing with terminology and symbols, methods of test, dimensions, and quality of materials; and those concerned with procedures such as drawing office practice, codes for operation, maintenance, etc. There was a considerable amount of technical knowledge embodied in British Standards and teachers should draw attention to the way they could be used, for example, to simplify production, placing orders, maintenance of stocks and replacement. About eight hours of a student's lecture time might be devoted to this subject. This raised the question of suitable training and lecture material for the teaching staffs of universities and colleges. (*b*) For those who are, or hoped to be, standards engineers, the course should provide more detailed knowledge of the items under (*a*), of how national standards are prepared, how to select and use them in a particular firm, such as in preparing particular specifications. Instruction should also be given on the principles of designation and classification, and on the use of codes for numbering of parts and components. (*c*) For management, who are responsible for deciding the standards policy of the firm and for determining the range of products, the courses might deal with the cost factors in standardisation, the procedure for arriving at a selected range, the education of users to encourage acceptance of a reduced range, and the adoption of quality control to ensure that a product conforms to the required standard.

Replying to a question raised during the discussion concerning the availability of British Standards for students, Mr. G. Weston (technical director, BSI) said that standards could be obtained at a considerably reduced price for educational purposes.

The committee had been in touch with the Standards Engineers Society of America and a suggestion made by the Society that a British section might be formed, as had been done in Canada and one or two other countries, had been considered. The committee, however, as a whole, felt that standards engineers in this country should collaborate closely with the American society without forming a branch of it.

Mr. R. B. Armstrong (Marconi's Wireless Telegraph Company) in his paper outlined what, in his opinion, were the main operations for which a standards engineer in industry should be responsible. Standardisation was not an end in itself, but a means to an end. As the chairman of the conference remarked, no-one in industry liked standards as standards; they were only useful if it led to more economic productivity or an improvement of output for a given input. In Mr. Armstrong's view there were three main fields of activity in which standardisation could be of benefit: (*a*) In the purchase of raw materials, and the purchase or manufacture of component parts for marketed products. This was probably the first and easiest field for applying the principles of standardisation. The standards engineer had to select and classify the items which could be made the subject of standards. It involved setting up an efficient service organisation working smoothly and providing the necessary information in suitable form to all the departments concerned. (*b*) In design and production. The standards engineer essentially took an active part in each of these fields by agreed limiting of the range of raw materials, components and piece parts normally specified by the designer. New products should be designed with a full knowledge of the standards available, right from the start, rather than seeing how standards could fit the completed design. By collating data codes of design practice and standard production practices might be formulated. In the case of the large-scale production of well-established items not subject to major design changes, the standardisation of production plant and processes might form the main field for the standards engineer. (*c*) In marketing—and possibly maintenance—of the end products. This was a special field of study which, in the United States, had often been the concern of the standards engineer. In this country this field of activity had been regarded as outside the province of the standards engineer, but, bearing in mind the extent to which he contributed to the return on capital invested in his organisation, it could prove to be one of the most useful functions of standardisation. For example, it has been claimed that in many organisations 80 per cent of the profits accrued from only 20 per cent of the different products marketed. In the case of a manufacturer of automobile components, 90 per cent of the profits were obtained from 10 per cent of the products marketed.

The chairman suggested that there was no such person as a standard standards engineer, each had to adapt himself to the particular organisation with which he worked. It might take one to three years to collect data on which to base a standard. He advocated the man with a small firm being granted leave of absence to attach himself to the standards organisation of a large firm in order to gain experience of this type of work. It was a whole time job and opportunity should be afforded to cut across all lines of communication, at all levels.

PRODUCTIVITY AND PROFITABILITY FILMS

Three new 16 mm sound-films have recently been issued by the British Productivity Council: "Method Study in the Office," presenting selected case histories of method study applied to clerical and administrative procedures; "A Nation of Shopkeepers," illustrating method study techniques applied to an ironmonger's shop—again, based on an actual study carried out in a small North London shop; and "Variety Reduction," illustrating the benefits of end-product standardisation.

This last film is a masterly example of what a propaganda film should be—scripted, directed and acted with a professional attack that is so often lacking in presentations of this sort. The whole action takes place within the four walls of a managing director's office. Here the executive staff of an anonymous company are gathered to discuss the proposals of a consultant who advocates a scrutiny of the items in the catalogue with a view to eliminating those which contribute least to the profitability of the firm. The arguments for and against such a policy are forcibly put and, in the course of the discussion, its implications for the design, production, sales and accounting departments are brought out.

Discussion notes are available with the films, which may be hired from the Central Film Library, Government Building, Bromyard Avenue, London, W.3, or bought from the British Productivity Council, 21 Tothill Street, London, S.W.1.

Automobile Engineering

ANTI-SKID UNIT FOR AUTOMOBILES

An anti-skid device for automobiles which permits maximum braking effort but prevents wheel lock and resultant skidding, has been developed by the Dunlop Rubber Company Limited, Coventry. It has evolved from their well-known Maxaret anti-skid gear, which is now fitted on many civil and military aircraft. It is interposed between the driver's control valve and the brake in such a way that it relays the effort applied by the driver and immediately relieves the pressure in the brakes when an increase in angular wheel deceleration gives warning of impending wheel skid. The driver can apply full braking effort in the knowledge that the anti-skid units will hold a delicate pressure balance at the brakes at near-optimum braking effort.

The operating principle of the unit is simple. A small flywheel is driven from each braked wheel through a spring clutch. During deceleration of the wheel if there is no tendency to skid, the energy given up by the flywheel is not sufficient to collapse the spring and no operation of the unit takes place. Ultra-rapid wheel deceleration, such as occurs when a skid is developing, causes the flywheel to collapse the spring, and a small hydraulic valve mechanism is operated to relieve the brake pressure until the flywheel returns to its normal position as the wheel regains non-slip speed.

Tests have been carried out on a high-powered car fitted with hydraulic disc brakes controlled by these units. The conditions varied between the extremes of smooth treadless tyres running on a specially laid skid track to fully-treaded tyres running on dry textured surfaces. Friction values achieved between these extremes varied from 0·1 up to a maximum coefficient approaching 1·0. Tests have been made at all speeds up to the maximum of the test car, which was 95 m.p.h. They have shown that in terms of stopping distance the advantage of the anti-skid system is very marked, particularly at high speeds, as it enables the driver, irrespective of his ability, to maintain maximum deceleration while still having complete directional control over the car. On the other hand, in the case of a car driven without the Maxaret unit by a person of normal driving skill, the brakes are invariably released as soon as the car makes the slightest deviation from its normal course, even though the wheels are not fully locked. The use of Maxaret anti-skid units results in considerably greater braking power being available to the driver than is normally the case.

Although tests so far have been confined to a private car at constant weight, it is confidently expected that the anti-skid system will show up to still greater advantage on commercial vehicles. Its use would automatically adjust the braking torque at each wheel to the weight carried by the wheel, in addition to catering for normal tyre to ground variations. The undoubted extra safety that such a system would bring to the operation of heavy vehicles, particularly the articulated or semi-trailer type, could well result in its being considered essential in countries where these vehicles are not subject to speed restriction.

In short, Dunlop hope that fitted to high power cars and heavy commercial vehicles, the Maxaret will prove to be an investment in safety which will substantially reduce the growing accident rate on our congested roads.

Special Article

PROCESS PLANT

The Chemical and Petroleum Engineering Exhibition

The Chemical and Petroleum Engineering Exhibition—first of its kind to be held in Britain—occupied the Grand and National halls at Olympia, London, from 18 to 28 June. Organised by F. W. Bridges and Sons, it had the active support of the British Chemical Plant Manufacturers Association and of the Council of British Manufacturers of Petroleum Equipment. During the latter part a conference organised jointly by the Institution of Chemical Engineers and the Institute of Petroleum was held, the subject being the Organisation of Chemical Engineering Projects. We hope to give a report of this conference in a later issue.

Being a specialist exhibition it was at no time crowded, but exhibitors reported a volume of sound enquiries and some were very satisfied with the business done. Comment was generally expressed that the Exhibition presented a bright and lively appearance indicative of the very large capital investment—some £700 million in the last ten years—that Britain is making in the chemical field. At present Britain is the second largest consumer of chemical and petroleum products in the world.

Chemical plant does not always lend itself to exhibition, not least of all by reason of its size, and therefore it was not surprising that the trend of displaying working models, already noted some while ago in these pages, should be borne out. Particularly was this the case where transparent materials could be used to show the flow of a process. Other examples were the displays of complete plant layouts as for a refinery or for the heavy-water plant shown by Petrocarbon Developments Limited (Fig. 1). Apart from exhibits, models play an important part in designing plant layout. The Kellogg International Corporation had a $\frac{3}{8}$ in to 1 ft scale model of an ethylene plant made up from prefabricated plastics components. Pipes and pipe fittings are a push fit and valves and the like clip on to them. Scale girders can be fixed together with adhesive and there are mouldings for pressure vessels, reactors and other such items. The great advantage is of course that designs can quickly be altered if it is seen that they are not practicable; perhaps there is a valve that cannot be reached for servicing or two pipes foul one another. Such faults can easily be eliminated by this means in the early stages of design. Similar methods have been used (and described) for factory planning.

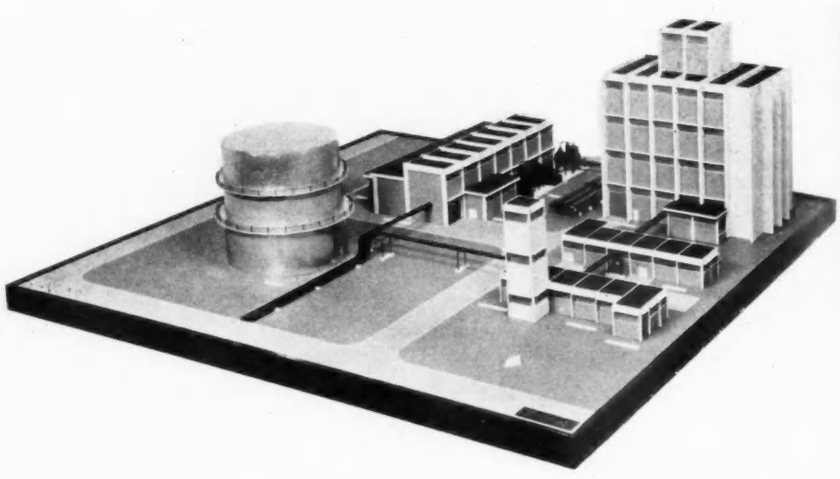


Fig. 1 Plant layouts can best be displayed by the use of scale models, as this example of a heavy water plant. Petrocarbon Developments Ltd.

PUMPS

It has been said, and with considerable truth, that pumps are the hearts of chemical and process work. It was natural therefore that there should be a large number of pumps on show. Among them was a new range of flame-proof units by Worthington-Simpson Limited, designed for groups I and II gases and in powers from 1 h.p. to 12½ h.p. These were of the firm's patented Monobloc design and have the impellor mounted directly on the shaft of the driving motor. Two speed ranges are included: 1,450 r.p.m. for powers from 1 to 7½ h.p. and 2,900 r.p.m. for the range from 1½ to 12½ h.p. In addition to being flame-proof, the motor is of very robust design to withstand rough usage. The range will eventually be extended to include all standard sizes made by the firm. An example of the range is given in Fig. 2. Other items shown were from the chemical pump and compressor ranges including units in Westhite and Hastelloy.

A self-priming centrifugal pump of new design was among those on the stand of Rhodes, Brydon and Youatt Limited, makers of the Mopump series. This new version has been intended particularly for handling volatile liquids and is claimed to have a very high efficiency due to the double shrouded single-entry impellor. The casing has been constructed to hold a sufficient quantity of priming liquid to avoid the need for a non-return valve. There are at present four sizes with impellors running at 1,450 and 2,900 r.p.m. Tests have been made at lifts up to 18 ft on petrol without any sign that the limit had been reached. It is also claimed that the pump does not suffer from over-heating of the priming liquid. The impellor is close-coupled to the driving shaft, and both motor and impellor can be withdrawn without disturbing the pipe work. Mechanical seals can be fitted, and the self-priming action does not depend on close clearances round the impellor.

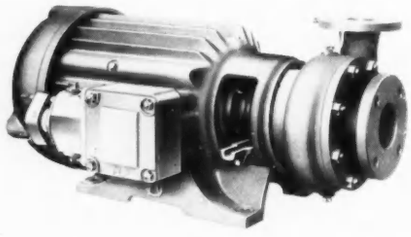


Fig. 2 Flame-proof Monobloc pump for gases in groups I and II. Worthington-Simpson Ltd.

An example of the type of pump in which the liquid does not come into contact with the casing or impellor is the tube diaphragm pump that was shown by Merrill Pumps Limited a diagrammatic section of which is illustrated in Fig. 3. This consists of a tube of some rubber chosen to suit the liquid being handled, above and below which are non-return valves. A reciprocating piston is driven by an electric motor and alternately compresses and releases the tube by means of an hydraulic fluid, usually water. The pumps can be mounted with the tube vertical or horizontal as desired, and there are also units mounted on trolleys. Three sizes are available: 0 to 12 g.p.m., 12 to 25 g.p.m. and 25 to 50 g.p.m. The suction lift that can be obtained is 20 ft and delivery heads up to 200 ft are possible on the standard models, or up to 100 lb per sq. in on special versions. Such pumps are particularly suitable for handling corrosive chemicals or abrasive slurries and in fact can handle any fluid for which a suitable tube material is available.

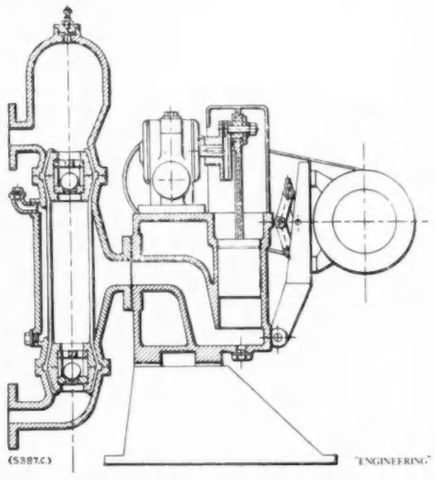


Fig. 3 Tube diaphragm pump operated by a reciprocating piston. Merrill Pumps Ltd.

DIAPHRAGM VALVES

The same firm were also showing a glandless diaphragm valve again using a tube as the sealing member. A cranked rotor with an elliptical cross section passes through the tube and is journalled in caps at each side of the pipe line. Turning the rotor by a wrench or spanner, therefore, brings the cranked portion across the flow and eventually closes the valve completely. In the open position the rotor is withdrawn into a recess in the valve body. The seal is made against a raised machined seating. No maintenance is needed until the tube becomes too worn to effect a seal and then all that is required is to remove the end caps and withdraw the rotor one way and the tube the other. A new tube can then be inserted and the rotor replaced. In order to make the action very smooth it is possible to lubricate the rotor in the tube. In a sleeve version, the rotor is not cranked but is still elliptical in shape and is covered with a rubber sleeve. A single gland is then required.

What is claimed to be the first three-way diaphragm valve in the world was on the stand of the Talbot Steam Tube Company Limited. This is the Cupford valve which has for some while been in use in the Dutch dairy industry.

Within the body is a bucket shaped rubber diaphragm enclosing the operating cam. On the top of the body are a port selecting lever and the closing handle. To close a particular port the selecting lever is placed in the slot above that port and the handle is then turned to correspond to it, i.e., so that both the lever and the handle are in line. These actions first move the cam spindle into the required position and then rotate the cam to effect the closure. The port is opened again by turning the handle so that it points in the opposite direction to the selecting lever. The upper cap of the valve clamps the top flange of the diaphragm to the body so that neither the cam nor the top cap come into contact with the liquid; both can therefore be made of some less expensive material than the body and bottom cap which are normally produced in 18/8 stainless steel. A stainless steel bush supports the diaphragm against damage. Sizes available are from 1 in to 3 in and the closing force can be adjusted to suit the pressure in the line. This provision allows the wear on the diaphragm to be kept to a minimum. It is also possible to rotate the diaphragm through angles of 90° to even out the wear. Full inspection of the inside can be carried out by removing the bottom cap—an operation that can be performed even when one port is closed and under pressure.

EXTINGUISHERS

Since so many of the materials handled in the chemical and petroleum industries are inflammable, it was right that the various firms concerned with the manufacture of fire-fighting equipment should be displaying their wares. One of the newer items was the Fireball on the stand of Foamite Limited and shown in Fig. 4. The spherical welded steel container holds 150 lb of dry powder and is mounted on rubber tyred wheels for quick action. The hose is 30 ft long and is wound so that it can be uncoiled without kinking; at the end is a pressure-relieved pistol control giving almost a hair trigger action. The spray is in the form of a flat fan and will discharge the whole 150 lb in one minute. Pressure is supplied from a standard 5 lb carbon dioxide cylinder. One special feature of the apparatus is that the sphere can be relieved of pressure after use without having to discharge the whole of the contents; this enables it to be topped-up very quickly after a brief discharge. The sphere can also be lifted from the trolley if desired. Complete and ready for action, the whole weighs 326 lb.

The same firm were also showing a dry powder tender mounted on an Austin Gipsy chassis. Two 200 lb containers are set behind the seat, linked to two 60 ft lengths of non-kinking hose wound on drums at the rear. These hoses are fitted with the same flat discharge nozzles described for the Fireball. On each side are three 20/25 lb dry chemical extinguishers of the firm's standard type. Headlights and a spot light are fitted on the front of the vehicle. It is claimed that this tender is one of the cheapest on the market. There is accommodation for the driver and two crew. Also available and mounted on the same chassis are a water pump set and a foam set. Both use Coventry Climax 510 g.p.m. pumps; the first carries 40 gallons of water and the second the same amount of Air-foam liquid. There is also a 100 gallon water tank trailer which can be towed behind any of the vehicles.

Fig. 4 Fireball dry powder fire extinguisher; discharge rate 150 lb per min. Foamite Ltd.

TANKER FILLING

A type of centralised filling control was exhibited on the stand of Gilbarco Limited. This involved a Lindars automatic control unit coupled to Brodie-Kent positive displacement meters. The whole offered a means of remote control for filling tankers at a depot, but of course could be adapted to many other purposes. As set up on the stand, three metering pumps were controlled from a single central point. In imagination the road tankers would drive into the depot and be directed to one of the pumps by the man in charge. The required amount would then be set up on the control dial and the switch turned to the pump in use. Filling would then proceed automatically, at first rapidly then, when the amount was nearly complete, more slowly (the control valve being air operated from the central panel) so that the final amount was exact. At any time, the main panel showed the amount still to be supplied or, by turning a switch, the amount already put in. A connection to an automatic printer made possible a record to be made of each operation or of the total amount supplied during the day, of the time at which the delivery was made and of any other chosen information selected by a punched tape programme. This is essentially custom-built apparatus, but being made from standard items it can be both cheaply and quickly produced.

PACKAGED BOILER

The Cleaver-Brooks Monitor package boiler was one of the items on the stand of Marshall Sons and Company Limited. One model is illustrated in Fig. 5. The ratings range from 500 to 2,000 lb per hour at 150 lb per sq. in with a guaranteed efficiency of not less than 80 per cent. They are designed for firing with a light gas oil.

The fire tubes are arranged to give a four-pass operation using a forced draught supplied from a cast aluminium blower. The same motor that drives the blower also drives the oil pump through a belt. The burner assembly is of the pressure atomising multi-nozzle type with automatic two stage ignition. Operation is on the off-and-on principle and in all but the smallest boilers the main burner nozzle is lit from a pilot nozzle after a timed interval. Combustion control with a timer motor establishes a time schedule for each phase of burner operation.

Five square feet of heating surface is provided for each boiler horse power. The hinged and davited doors allow easy access for cleaning and maintenance.

ROTATION INDICATOR

For remote indication that an item of machinery is still rotating, Londex Limited were showing a sensing device among the many examples of their automatic control apparatus. It is shown on Fig. 6. The unit was originally developed in collaboration with Imperial Chemical Industries Limited for use on stirrers, band conveyors and the like. The drive to be monitored is fitted with one or more cams which cause the follower arm to be lifted once or more during each revolution. This follower is attached to a rocker shaft which carries an insulating bar that operates a set of contacts each time the arm is lifted. The shaft enters the back of the casing through a bonded rubber bush which acts as bearing and return spring, and also provides an almost complete seal. While the contacts are operating, that is while the mechanism is rotating, a condensor circuit maintains a relay; when movement ceases the relay is de-energised and the alarm sounds. The whole circuit is designed to fail safe.

The standard unit covers a range from 30 to 300 r.p.m. and the alarm sounds between 2 and 6 sec. after the drive under control ceases to rotate. Normal operation is for 25 volts a.c. The contacts for the alarm circuit are rated for 5A at 250 V a.c. and those operated by the rocker arm have a life in excess of 100 million operations; replacement is simple. The rubber bush gives a restoring couple of approximately 5 oz-in and the follower arm movement at $5\frac{1}{2}$ in is $\frac{5}{16}$ in with a safe overtravel of $\frac{3}{4}$ in. The standard unit as shown in the illustration measures 13 in by $6\frac{1}{2}$ in.

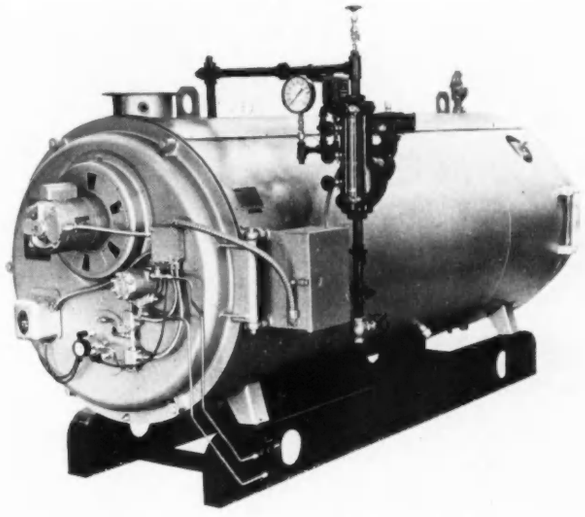


Fig. 5 Cleaver-Brooks Monitor oil-fired packaged boiler. Marshall and Sons Ltd.

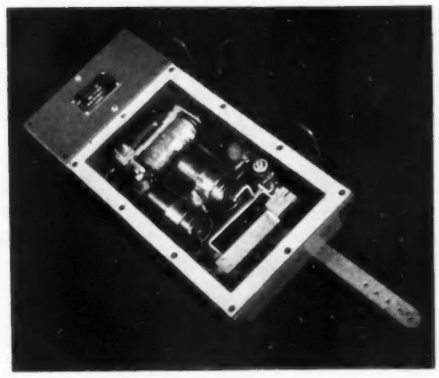


Fig. 6 Sensing device to indicate continuity of rotation. Londex Ltd.

In Parliament

NO BUYERS FOR DISUSED BRANCH RAILWAYS

After midnight one day last week, or rather at 12.45 the following morning, to be precise, there was a brief debate in the House of Commons on the fate of disused railway branch lines, introduced by Viscount Hinchingbrooke (Independent Conservative).

He told the House that he had found that, from 1950 up to the present time, 155 branch lines had been closed down, covering a route mileage of 1,772, and achieving an estimated minimum saving to the British Transport Commission of about £1,677,000 per annum. The estimated book value of the assets displaced, including stations, appeared to be around £8,723,000, against which there were receipts by the Commission of some £2,184,000 for land sold. There was thus a difference of about £6,540,000 between the two amounts. How much of the difference, he wondered, represented a book loss on assets which had, in fact, been disposed of, and how much represented the value of disused property which had not yet been sold?

There were one or two other points which he would like to raise. For instance, he would like to know the Commission's policy in regard to the disposal of the land when branch railways went out of use. What happened if the adjacent land owner was not interested in it? He felt that if the Commission were to declare its policy for the future of branch lines, and to announce that these lines would be sold by tender to any suitable bidders, the necessary capital would be found.

It should be possible to operate these lines by private enterprise. In his youth, Viscount Hinchingbrooke said, he had been a model-railway enthusiast, but that fact certainly did not take him now to the point of envisaging vintage locomotives puffing up and down an old-fashioned branch line, as a sort of "Emmet's Rural Rides." He considered that the analogy that would be much more perfect would be that between the British Overseas Airways Corporation or British European Airways and private airline operators.

Replying for the Government, Mr. G. R. H. Nugent, Joint Parliamentary Secretary to the Ministry of Transport and Civil Aviation, said that, as regards the prospect of selling a branch railway line, no buyer had purchased one so far. A private company had been formed in the Isle of Wight in 1955 to purchase branch lines there, but, in the event, no proposition had yet appeared which the Commission could seriously consider. The same comment applied to the Welshpool-to-Llanfair line. That light-gauge railway had been closed in 1956 and, there again, there had been talk about its purchase, but no firm and reasonable offer had been made to the Commission. Nobody had felt able to risk his capital and labour on one of these propositions, which had such very limited prospects.

NO USE AS ROADS

An alternative method of disposal, Mr. Nugent said, was to dismantle lines no longer used. The rolling stock, the signalling gear, the rails and even the ballast, were all useful and could be sold, but the sites were, naturally, very specialised ones. They consisted of long, narrow strips of land which had been very carefully constructed across the country to be as level as possible. They varied between cuttings through the high ground and embankments on the low ground.

Such sites had no value except for a railway or some other track. It would be possible to construct narrow lanes along them, but that was no use; there were too many narrow lanes already. They were much too narrow to construct on them modern dual carrigeways of the kind that were needed. In one case only had it been possible to use part of the site of a disused railway line: that between Merthyr and Abergavenny in South Wales, where the old track had been incorporated into the new Heads of the Valley road, as part of the extensive road which was being built from the Midlands towns to South Wales ports.

In practice, the best that the Commission could do with the land was to offer it to local landowners and hope that, in order to join up separate parts of their property, they would be willing to acquire it. One problem was to prevent old railway sites being choked with brambles and becoming a harbour for vermin. If there were any hero prepared to take over a complete railway line, and to make a firm offer, the Commission would be only too delighted to sell him the whole bag of tricks. It had to be accepted, however, that when a line was closed its commercial prospects were so dim as to be practically non-existent.

He accepted Viscount Hinchingbrooke's figures. The net loss of around £6·5 million on the sale of the assets of disused lines was virtually a book loss and related to the book value of those lines at the time when the Commission took them over from the previous public companies.

A great deal of research would be needed to find how far that figure represented unsold, disused lines.

GRANTS FOR RESEARCH WORK

On another day, there were a number of questions relating to the assistance given by the Government to research activities of various kinds, ranging from the cotton industry to harbour design and coil springs.

Mr. Anthony Kershaw (Conservative) asked the Parliamentary Secretary to the Ministry of Works to state which bodies outside the Government service advised the Department of Scientific and Industrial Research on the making of grants for promising research work in engineering and science at the universities, colleges, and similar institutions. Further, how did the present expenditure on nuclear physics research, and research in other directions, compare with the amounts spent in previous years?

The DSIR, Mr. Harmar Nicholls said, was advised on grants for special researches by the research grants committee of the Council of Scientific and Industrial Research, though the committee might seek the views of outside referees on any application. The chairman of the committee was Professor P. M. S. Blackett, F.R.S., and its members were scientists of distinction in relevant research subjects. The chairman of the University Grants Committee and the physical and biological secretaries of the Royal Society sat as assessors. As to the present expenditure on research in nuclear physics and in other directions, there had been a steady increase in both over previous years. The grants for nuclear physics amounted to £330,000 this year, compared with £192,000 last year. In respect to other than nuclear physics research, the Government grant had grown from £80,000 two years ago, to £155,000 last year, and to £320,000 this year.

DESIGNING SMALL HARBOURS

Replying to a question by Mr. Ray Mawby (Conservative) regarding steps being taken to improve the design of small harbours used by fishermen, Mr. Harmar Nicholls said that the Hydraulics Research Station of the DSIR had been engaged on studying problems affecting three fishing harbours in the United Kingdom: Southwold, Great Yarmouth, and Eyemouth. As a result, it had been found that wave action could be reduced at Southwold and the entrance made safer for ships of greater depths; while, at Great Yarmouth, a re-designed South Pier would reduce turbulence and the immediate danger from scouring. Then again, useful information on how to deal with the bank of sand that built up at the entrance of Eyemouth Harbour had been obtained from experiments on a scale model. The Hydraulics Research Station undertook to advise on all harbour improvement works, up to the limit of its capacity. It undertook research when harbour authorities invited it to do so, provided that they were prepared to pay the cost, and it was for these authorities to put into operation the results of the investigations.

COIL SPRINGS INDUSTRY

It was Mr. Bernard Braine (Conservative) who raised the question of progress in research in the coil springs industry. He wanted to know what steps had been taken by the DSIR to ensure that research facilities available to that industry were adequate in relation to the facilities afforded for research on other forms of springing.

Mr. Nicholls said that the Coil Spring Federation Research Organisation which was supported, by the department, had recently completed plans for the construction of a new research laboratory in Sheffield, which would provide improved facilities for research on the characteristics of springs and the materials used. It was hoped that, ultimately, all forms of springing would be investigated. The present position was that, provided the industry raised £7,000 a year, the Government grant would amount to £4,000. Above those figures, the Government would contribute £100 for every £100 subscribed by the industry, up to a further £4,000.

West Germany Competes for Ships

Attention was drawn by Mrs. Barbara Castle (Labour) to the embargo on the construction in Britain of whale factory ships for export to the Soviet Union. She asked the President of the Board of Trade if he was aware that the German State Shipyards at Kiel had built and shipped to Russia 24 of such vessels, and that trade between West Germany and the Soviet Union and China was growing steadily. It was time that British shipyards had a look in on this trade and that a blow should be struck for British industry. Sir David Eccles replied that the information given by Mrs. Castle was new to him and that he would look into it at once. So far the West German Government had observed the embargo very well.

Government Using more Computers

Sir Ian Fraser (Conservative) asked the Chancellor of the Exchequer about the use being made in the public service of electronic computers and similar devices, in order to economise in the employment of manpower. He felt that Government departments were falling behind in the matter. Mr. J. E. S. Simon, the Financial Secretary to the Treasury, said he could not agree. At present, four Government offices had been equipped with computers and orders had been placed for equipment for a further four offices. Studies of the possible use of computers in five other offices had almost been completed. The record of Government departments in this respect compared very well with that of private industry.

Economies from Use of Metric System

Mr. R. Gresham Cooke (Conservative) felt that the Government should give a lead to the nation by providing a practical demonstration of the financial savings that would accrue from the adoption of the metric system, particularly in respect of weights and measures, as instanced in the report of the Hodgson Committee, which was now some five years old. He asked that the Treasury should arrange for its organisation and methods department to make an estimate of the savings which would accrue if the system were adopted for all Government work. Mr. J. E. S. Simon declined to order such an investigation on the ground that it would involve disproportionate trouble and expense. He pointed out that, last month, the British Association had set up a committee, under the chairmanship of Sir Hugh Beaver, to examine the problem and he thought it would be wise to await the result.

Atomic Review

Point Sequence

By tracing with a pencil a sequence of numbered points in certain kinds of puzzle one is eventually presented with a face or other picture. The points enumerated below are of a more random nature, but may perhaps provide some picture of current nuclear developments.

Euratom Plans

Last week the United States Government and the Euratom Commission published the first official details of their proposed joint nuclear power and research programme centred on large-scale atomic reactors of an installed capacity of 1 million electrical kW to be brought into operation in the Euratom countries by 1963.

The programme is described as a two-way plan offering benefits to both sides. The Euratom countries will gain from United States experience and capacity in order to make a rapid start on the nuclear power development they need to meet their ever-growing shortage of energy; while the United States for its part will gain experience in Europe on large-scale atomic reactors which the lower cost of conventional power-stations in the United States would make it less economical to build in America. The total capital cost of the construction to be undertaken is estimated at 350 million dol. A ten-year joint research and development programme, also proposed, will cost during its first five years a further 100 million dols. The Euratom Commission and the United States Government will jointly establish technical standards and procedures for selection of reactor projects, which may be proposed, constructed, and operated by private or public bodies.

The chosen reactors, which must be of proven types on which research and development has been carried to an advanced stage in the United States, are likely in the initial stage to be pressurised-water or boiling-water reactors using enriched uranium. It is expected that some six to eight of these reactors will be built in the various Euratom countries, their size varying from 100 to 150 MW capacity.

The fuel for the power programme is expected to amount to 30,000 kg of slightly enriched uranium. The United States Atomic Energy Commission guarantees full supply of this material for 20 years' operation at United States domestic prices in effect at the time of transfer.

M. Kohnstamm and M. Foch, representing the Euratom Commission, have completed a two-day visit to London during which they had talks with representatives of H.M. Government and the United Kingdom Atomic Energy Authority. There was a useful exchange of views about methods of collaboration between Euratom and the United Kingdom, and in particular about the contents of a possible collaboration agreement between H.M. Government and Euratom.

America and Euratom

The relationship between Euratom and the United States raises two fundamental questions according to a pamphlet by Ben T. Moore published by the Twentieth Century Fund, an American research institution. These questions are: is a vigorous and integrated programme of nuclear development by the Six desirable from the American point of view? And secondly, if it is desirable, what should the United States do to encourage and assist them? The answer to the first question is that it is in America's interest to see Europe economically and politically strong. Euratom can help to make this goal possible by a rapid development of additional sources of power. It can reduce the dependence of West Europe on oil from the Middle East. In Mr. Moore's words, it is essential "to ensure that oil remains a commodity and does not become a powerful economic weapon threatening Europe's survival." The author concludes that the United States should help the development of Euratom even though it may mean that a large and efficient European nuclear industry will eventually "compete with American exporters of nuclear equipment in third markets or even invade the American home market."

How can American resources and technical skill be used to help Euratom? The pamphlet suggests a number of ways. The AEC could help in Euratom's programme for training and research by exchange of scientists and technicians, and by close co-operation between United States national laboratories and Euratom's proposed Joint Nuclear Research Centre. Advanced laboratory equipment could be provided when this was not available in Europe and there could be increased contacts across the Atlantic between nuclear research workers in universities and industry. The United States could help Euratom to obtain supplies of fissile materials, in addition to meeting Euratom's needs of uranium 235.

Euratom's development programme is seen to offer "important profit opportunities" for American firms and a chance to get experience in producing and testing equipment on a large scale. The most difficult investment problem will be how to finance the Euratom reactor programme. Mr. Moore thinks that the United States should "consider substantial lending to Euratom, both public and private, if satisfactory guarantees of security and repayment for the loans can be worked out." A number of full-scale reactor prototypes must be built to test relative efficiency of different processes and reduce kilowatt-hour costs. But any agreement to help Euratom would have to include a guarantee that American materials, equipment and technology were used for industrial purposes and not for weapons.

OEEC and Test Reactors

The *First Report of the Steering Committee for Nuclear Energy to the OEEC Council*, published earlier this year, includes a table of test reactors, existing or planned, in Europe. The table, which was prepared by A. H. W. Aten Jr., of the scientific advisory committee, Netherlands Reactor Centre, is reproduced on this page. Previous reference to the European Nuclear Energy Agency and the Eurochemic Company, both of which are associated with OEEC, was

Test Reactors Existing or Planned in Europe

Type	Belgium BR-2	France El-3	Italy Ispra-1	Netherlands Modified ORR	Sweden ORR	Great Britain	
						Dido*	Pluto
Start up	Late 1959	1957	—	—	1958	1956	1957
Heat production	50 MW	15 MW	5 MW	20 MW	30 MW	10 MW	10 MW
Fuel	90 per cent enriched uranium; charge = 4-7·25 kg	560 kg U 8 kg U 235 1·4 per cent U 235	2·2 kg U 235 20 per cent	2·4 to 4·5 kg U 235 20-90 per cent U 235	6·5 kg U 235 20-90 per cent U 235	2·5 kg 90 per cent U 235	2·6 kg 90 per cent U 235
Moderator	H_2O	D_2O	D_2O	H_2O	H_2O	D_2O	D_2O
Coolant	H_2O 10·5 m per sec $t = 51°$ max.	D_2O 5 m per sec $t = 60°$ max.	D_2O 100 litres per sec	H_2O	1,200 litres per sec $t = 50°$ max.	D_2O 4 m per sec	D_2O 4 m per sec
Reflector	Be	Inner: D_2O outer: graphite	Inner: D_2O outer: graphite	Be	Inner: Be outer: D_2O top and bottom: H_2O	Inner: D_2O (50 cm thick) outer: graphite (60 cm thick)	Inner: D_2O (50 cm thick) outer: graphite (30 cm thick)
Fuel cycle	½ of charge renewed every 19 days. Average burn-up = 55 per cent	↑			20 per cent burn-up ½ replaced every 3 weeks	20 per cent burn-up ½ replaced every 2 weeks	20 per cent burn-up ⅓ replaced every 2 weeks
neutrons per cm² sec thermal	Reactor loaded all test facilities $= 6·2 \times 10^{13}$†	10^{14} max.	$9·10^{13}$ max. $6·5 10^{13}$ av.	$1·5 \times 10^{13}$	10^{14}	max. 10^{14}	max. 10^{14}
neutrons per cm² sec fast	Reactor loaded all test facilities $=2·4 \times 10^{13}$†		$1·3 10^{13}$ max.	2×10^{13}	5×10^{14}	max. $1·4 10^{14}$† 2 group calculations	max. $1·4 10^{14}$† 2 group calculations
Horizontal beamholes	Facilities passing right through the reactor: 1 in the centre—8 in diameter	12 of 6 in 2 of 10 in	1 of 8 in through 1 of 12 in channel 6 of 6 in 12 of 4 in	8 of 8 in 2 of 10 in	8 of 6 in	1 of 10 in., 1 of 4 in × 2 in, 1 of 6 in, 6 of 4 in, 10 of 6 in (low flux)	4 of 7 in
Vertical channels	4 at the periphery—8 in. diameter 13 in the reflector—3½ in diameter Facilities in the core only: From 10 to 27 in the reflector—3½ in diameter From 4 at the periphery—2½ in diameter From 12-16 in middle of fuel elements—1½ in. diameter Facilities not penetrating the core: 5 radical—12 in diameter 2 radical—8 in diameter 4 tangential—8 in diameter	1 of 8 in centre core	1 of 6 in through 1 of 6 in channel 6 of 3 in thimbles	1 of 7 ft. centre core 1 of 8 ft. possible on pool side	1 of 6 ft. centre core 4 of 6 ft. outer core (either central channel to be loaded or 4 outer ones)	If desired 1 or 2 loops various thimbles 4 of 6 in., 5 of 4 in, 9 of 2 in	4 of 7 in 4 of 4 in
Pneumatic shuttles	2	4	4		2	2	0
Hydraulic shuttles	6	0		4	2	0	0
Other facilities	Gamma radiation: under-water, with fuel elements either in the dome or in adjoining premises	2 cooled cells in core, 2 cooled converters in core	2 isotopes channel 8 in. × 12 in below D_2O tank	—	—	—	—
Thermal column	—	7 ft × 7 ft	1 of 62 in × 62 in	Available. Alternating with the thermal column	4 ft × 4 ft In the pool	5 ft × 5 ft	None
Shielding tests	Possible	Facility available	—		—	—	—
x-ray channel	—	1 of 12 in	—	—	—	—	—
Drawings	Available	Available	—	Available	Available	Available	—

* A reactor of this type will be built in Germany.
† These figures for fast flux may not be strictly comparable with other figures as they include epithermal neutrons.

Continuing Atomic Review

made in Atomic Review last 14 February, 21 March and 13 June.

Europe, Iceland and Winfrith Heath

Various projects are under consideration or have already been approved by the European Nuclear Energy Agency. The ENEA's first report has recently been released through the OEEC, and its director M. Pierre Huet has stated that the agency's programme would be submitted to member governments this summer. It is reported that a committee presided over by Professor F. Perrin of France, and Sir John Cockcroft, has approved a 30 million dol (nearly £11 million) programme for building an experimental nuclear reactor for joint European use at the United Kingdom Atomic Energy Authority establishment at Winfrith Heath.

The Icelandic Government has invited European co-operation in connection with a proposed heavy-water plant; the project is under discussion. Other projects with which ENEA is concerned include a boiling-water research reactor to be operated at Halden in Norway, and a plutonium plant and research laboratory at Mol in Belgium.

Pulp Reactor

Representatives of Britain and five other countries have signed an agreement in Oslo for the joint exploitation of a heavy-water boiling reactor designed for steam power production for the wood pulp industry.

Reactor Conference

A reactor technology conference was held at the Atomic Energy Research Establishment, Harwell, on 11 June, 1958, when recent developments in the field were discussed with representatives of British industrial firms. 200 representatives from 86 British concerns attended. The conference was confidential and no proceedings will be published. After an opening address by Sir John Cockcroft, papers were read concerning the following topics: the advanced gas cooled reactor and the gas-cooled heavy-water moderated reactor, by Mr. S. Fawcett; the high temperature gas-cooled reactor system, by Dr. L. R. Shepherd; the fast reactor system, by Dr. H. Kronberger; technological progress on fluid metal fuels, by Mr. J. Smith, and the homogeneous aqueous system, by Mr. I. Wells; chemical processing, by Dr. J. M. Fletcher; and metallurgical problems in reactor systems, by Dr. P. Murray. Dr. B. F. J. Schonland, Director of the A.E.R.E. Harwell was chairman of the conference. A similar earlier conference with industry at Harwell was held on 30 November, 1956.

Switchgear for Hunterston

A recent order received by Metropolitan-Vickers Electrical Company Limited from the South of Scotland Electricity Board is for the 132 kV air-blast switchgear to control the output from the Hunterston nuclear power station. The switching station is unusual in that practically the whole of the 132 kV equipment will be mounted indoors, the site being on the sea-coast in an area particularly prone to atmospheric salt deposit.

The order covers the initial requirements of 15 circuits, each equipped with a Metropolitan-Vickers 3,500 MVA type GA6W4 air-blast circuit-breaker. Standard outdoor components will be used, but the station will occupy a rather smaller area than with the corresponding conventional layout. The circuit-breakers will be operated by compressed air and the isolators will be hand-operated. This, together with the introduction of ring-type current-transformers mounted in wall or isolator bushings, obviates the use of any oil in the main building.

Inside the main building will be a compressor room with double-bus compressor equipment, and a plant house with batteries, charging panels, low voltage, a.c. switchboards, relay and bus-zone boards. Main control will be from the power station, and high-speed impedance protection will be provided on the Neilston and Greenock lines.

Cost of Power from Hinkley Point

Speaking in Bombay recently, Mr. Paul Wolff, chief reactor engineer of the atomic power department, English Electric Company, said that based on certain assumptions, a 500 MW station would cost 0·425*d* per unit in capital costs and 0·185*d* per unit in fuel costs.

Mr. Wolff estimated that the capital cost of the Hinkley Point station, which will have a generating capacity of 500 MW, will be about £120 per kW, of which about £55 per kW would be the cost of the reactor, etc. This compared, he said, with roughly £150 per kW for the first nuclear power station to be built for the Central Electricity Generating Board, of which about £80 per kW was invested in the reactor and its associated plant, and roughly £70 per kW on the rest of the station.

In estimating the cost of power from Hinkley Point he assumed a Bank Rate at 6 per cent, an operating efficiency of 27 per cent, a 15-year amortisation, an 80 per cent load factor, 3,000 MW days per metric ton uranium fuel life, and a uranium fuel replacement cost of £15,000 per metric ton.

The largest single advance made in the Hinkley Point reactor furnaces was the larger reactor core, resulting in an increased efficiency of burning of the uranium fuel.

Weir Pumps for Hinkley Point

G. and J. Weir, of Glasgow, have received an order from the English Electric Company for ten Electrofeeders for Hinkley Point. The Weir order includes eight main feed pumps each discharging 1,150,000 lb per hour at 882 lb per sq. in, and two emergency pumps each with an output of 120,000 lb per hour at 882 lb per sq. in. Weir's are now supplying the feed pumps for three of the four new nuclear power generating stations under construction in this country.

Atomic Energy Board Proposal for Eire

The report of an atomic energy committee set up in March, 1956, by the Irish Government recommends the establishment of an Atomic Energy Board and the purchase of an atomic research reactor to be located in Dublin. The Board would have responsibility for the operation of the reactor, the custody of fuel, a programme of training and research, and for other matters. It is recommended that the reactor should be bought from a specialist contractor in Britain or the United States. The net cost of the American reactor mentioned in the report was estimated to be £330,000, while a British reactor would cost £620,000.

Model of Siemens pressurised-water reactor and panel exhibited at the recent Achema exhibition.

Purchase of Submarine Reactor Plant

The United States Congress has approved the sale to Britain of a nuclear submarine power plant based on a pressurised-water reactor. The plant is to be made by the Westinghouse Electric Corporation and is expected to cost about £9 million.

The First Lord of the Admiralty has confirmed that Britain has approached the United States Government for approval to buy a United States nuclear submarine propulsion plant. Speaking in the House of Lords, he said that it had now become clear that a number of difficulties still confronting Britain in research on her own unit could be readily overcome if it were possible to obtain American machinery, design information and manufacturing know-how.

USS Skipjack

A new nuclear powered submarine, USS Skipjack, similar in principle to the USS Nautilus and USS Skate already in service, was launched 26 May at the shipyards of Electric Boat Division, General Dynamics Corporation, Grunton, Conn, USA. The submarine has been designed for maximum underwater performance and is powered by a reactor plant designed and developed by Westinghouse Electric Corporation in co-operation with the Naval Reactors Branch, USAEC. The power plant incorporates advances in design based on improved pressurised-water reactor technology.

French Atomic Submarine

It is reported in *Chaleur et Industrie* that M. Baissas, assistant director of the Centre for Nuclear Studies, Saclay, France, has announced that construction of France's first nuclear powered submarine will soon start. The Q244, as it is called, should be launched in four years' time, and is expected to have a displacement of 5,000 tonnes. Natural uranium is to be used in the reactor power plant, in contrast to the enriched uranium that fuels the United States submarine Nautilus. Q244 will be used to familiarise crews with "*la navigation atomique*."

Achema 1958 Exhibition

At the Achema 1958 exhibition held in Frankfurt the latest techniques in the use of radioactive isotopes were demonstrated by the United Kingdom Atomic Energy Authority.

The methods used in England to follow the movements of shingle under the combined action of waves and tidal currents with the aid of radioactive material was shown in a pictorial model. Other items will demonstrate how radiations can be used to measure fluid levels accurately for all types of vessels and liquids; the location of leaks in underground pipelines; to provide light sources which need no fuel or maintenance; to control insect pests; eliminate static electricity; thickness measurement and industrial radiography. Some recent work on the uses of strong sources of radioactivity for such purposes as food preservation and sterilisation of pharmaceuticals, were on view, and one of the models showed a possible way in which industrial products can be irradiated after being packed.

Other items exhibited at Achema included a model of a pressurised-water reactor to be marketed by Siemens; it is illustrated on the left. The full-scale reactor will have an output of 100 kW.

Isotope Division, AERE

A useful publication, describing the work of the Isotope Division, AERE, has been published by the UKAEA. At present the major part of the Division is at Harwell, while the technological irradiation group is at the Wantage Radiation Laboratory. It is expected that by the end of 1959, most of the Division with the exception of production group will have moved to Wantage.

Companies in the News

Vickers and Rolls-Royce

The annual reviews by the chairmen of two of our engineering giants, Vickers Limited and Rolls-Royce Limited, make an important contribution towards a solution of the problems of the industry as a whole. Both companies have had for many years a heavy stake in armaments, particularly in military aircraft and naval units. Both have therefore, in a more acute form than most other engineering companies, a problem of transition from armament to civilian work. Also, and increasingly, because of the wide spread of their engineering interests they are vitally concerned in the successful development of products for which a good export market exists or can be developed. The emphasis will therefore tend to be placed on products which can only be designed and made in highly industrialised states by companies able to earmark substantial sums to research and development. The scale on which Vickers and Rolls-Royce operate is immense—their turnovers in 1957 were £205 million and £91 million respectively and their trading profits £15·2 million and £5·4 million.

Reviewing the position, Viscount Knollys, chairman of Vickers, pointed out that the proportion of aircraft work had fallen from 40 per cent of total turnover to 34 per cent (£70 million) and that of shipbuilding risen from 15 per cent to 20 per cent (£40 million). General engineering at 27 per cent and steel manufacture at 19 per cent showed little change on the previous year. The policy of the company, said Lord Knollys, was "further to diversify our existing commercial products and, at the same time, to add to the range wherever possible in order to spread our interests more widely over the commercial field and thus to offset the inevitable reduction in armament work which, fortunately, is gradual in its effects."

Lord Kindersley, chairman of Rolls-Royce, has basically the same problem, in a more acute form. Although they do not indicate the relative importance of their various products, Rolls-Royce are almost certainly dependent on armament work for more than half their turnover, perhaps as much as two-thirds. The increase of £11 million in turnover recorded in 1957 was "almost entirely attributable to deliveries of aero engines for civil airlines and overseas governments," the latter being sales of military equipment representing "a substantial part" of total engine exports which in turn account for over half total engine production. Lord Kindersley made the point—in respect of both aero engines and motor cars—that a healthy and expanding home market is essential "to enable exporters to compete in international markets in the knowledge that they are working from a firm base." In the case of aero engines, he foresees a total loss of the military market to the United States "if the domestic effort on military types is to decline," and argues that the total output of British civil aircraft must be encouraged to grow considerably "if it is to provide the turnover to sustain an adequate programme of engine development."

Murmur of Machine Tools

The latest information on machine-tool order intake suggests a partial recovery in demand, but the general outlook is still uncertain. The Government's decision to increase initial investment allowances may, however, provide the necessary push to reverse the trend of the past few months. At the present time the industry remains apprehensive. Two annual reports throw some light on the position. Charles Churchill are doing well, rather better than the industry's statistics so far this year would infer. They experienced a severe fall in orders received during the first half of last year, but there was an increase of 16 to 17 per cent during the second half, and their chairman, Mr. J. B. S. Gabriel, expects a further increase this year. Although he makes no direct reference to his company's prospects his general remarks and the tone of his speech suggest confidence.

Wadkin Limited, who specialise in the manufacture of woodworking and non-ferrous metal machine tools, are much less inclined to take an optimistic view. Their chairman, Mr. J. B. Bullivant, states quite bluntly that in their case the post-war boom is definitely over. The cuts in the defence programme are reducing the demand by the aircraft industry for their metal working machines and the furniture industry is going through an acute depression. As a result, the Sagar factory at Halifax has been closed and various other steps have been taken to integrate the ranges of products made in the various factories of the group, and to rationalise the manufacture of machines throughout. Mr. Bullivant concluded that they have now come to the point where they can rely "only on normal requirements, new ideas and methods, and the hope of trade with those countries which so far have been barred to us."

The group's sales fell by 8 per cent during 1957, and there is no sign of a recovery. For the first time overseas competition includes Russian exports. Mr. Bullivant justifiably complains of the restrictive measures taken by the Government to restrict investment. These have made it difficult for the industry to compete effectively, due to a reduced volume of work through the shops, and the recent reversal of this policy is therefore welcome.

Help for Wales

There have been two developments in the last week or so in the economic development of South West Wales. It is as well that there should be, for the Government's proposals, announced at the time of the Budget to give special help to areas of high unemployment, are taking an unconscionable time to put into action. The Pressed Steel Company is to transfer its refrigeration division from Oxford to a new factory at Swansea. This will eventually give work to about 4,000 people. The transfer will be by stages and all workers now engaged on refrigeration will be employed in the motor-car body division except for key personnel in refrigeration who will be transferred to Swansea on a voluntary basis.

The announcement said that the Government would provide Pressed Steel with a large factory. It will have a floor area of 600,000 sq. ft and will cost anything up to £2 million to build. It will be leased to the company for 21 years with option for renewal. It is expected to be completed in the spring of 1960. Presumably, there have been inducements offered to the company in the form of an attractive rent to move a whole division into South Wales.

The second announcement has been from the Esso Petroleum Company Limited, which has now decided to proceed with its refinery installation near Milford Haven at a cost of £18 million. The new refinery is planned initially to process 4·5 million tons of crude oil a year (by comparison, 10½ million tons of crude oil are processed at Esso's Fawley refinery near Southampton). It is expected that the new refinery will save over 40 million dol a year for the United Kingdom balance of payments.

Tyres and Accessories

The annual statement of Dunlop's chairman, Mr. G. E. Beharrell, contains a most instructive and detailed review of the group's activities. The trading results show a marked improvement, reflecting what Mr. Beharrell described as the "remarkable recovery in the British motor industry from the recession of the winter of 1956–57." Commenting on the unsettled conditions which are apparent and the repercussions these may have on international trading relations, he said: "it is clearly unwise for anyone to predict whether these conditions will persist. We hope they will improve." This hope, strengthened by Dunlop's own most gratifying results—during 1957 and also so far this year—is an expression of sober confidence in the group's ability to meet economic storms.

Trading profits rose by 31½ per cent to £19·9 million. Sales rose also, though by only 3 per cent, but there is no doubt that the company benefited to a major extent from the falls in the price of natural rubber and the price stability introduced by their policy of increasing the proportion of synthetic rubber used in tyre manufacture. Consumption of synthetic rubber in the United Kingdom, which was less than 5,000 tons in 1953, had risen to 57,400 tons last year against 181,600 tons of natural rubber. For tyres the change was even more marked, synthetics accounting for 33·5 per cent of the total against about 22 per cent in 1956. If the demand for tubeless tyres continues to increase, the consumption of synthetic rubber may well follow the United States pattern, where it accounts for about two-thirds of the total.

The expectations of Mr. D. L. Breeden, chairman of Wilmot-Breeden (Holdings) Limited, who are the largest suppliers of hardware for motor vehicles and domestic appliances, are even more positively confident than those of Mr. Beharrell. Commenting on the future outlook of his group he said: "the present position is an extremely satisfactory one—sales and future orders are rising—although the company must be prepared to meet more competitive trading conditions." The wonder of all this is the motor industry's recovery which, Mr. Breeden points out, was achieved "in spite of the introduction of dear money and continued restrictions on hire purchase and on all forms of borrowing."

Finance Corporation Regrets

The chairman of the Industrial and Commercial Finance Corporation, Lord Piercy, made one of the most incisive criticisms of the Government's financial policy yet published. Few men are as well placed as he is to be constantly in touch with industry, particularly the small and medium firms in industry who have something constructive to put forward. The corporation was set up by the banks with Government support to provide finance for those who could not obtain it from the money market, generally because they were too small or their projects in fields not yet or not enough known. Lord Piercy mentions two fields in which the small firm has led the way: electronics, a field in which, in his own words, "invention and progress has not been the sole prerogative of great concerns with large research departments." The other is the developing range of sub-contracting of small parts and assemblies, on which the motor industry is based.

ICFC have been completely hamstrung by the credit squeeze. They could hardly lend when the banks had been told not to do so and they were thus thrown back on what they could withdraw from customers no longer needing all their support, and from profits for over 70 per cent of the £18·7 million advanced or invested during the year. They received 344 applications from new customers but only 63 new accounts were opened and 20 were repaid. At 31 March the corporation were financing 629 firms.

Lord Piercy has this to say about the effect of the credit squeeze: "The increased investment in manufacturing industry of the last year or two has ceased." He comments that "the increase in this sector was salutory is hardly denied" and chides those who a year ago "were apt to identify the increase in investment in manufacturing industry as the chief factor in the current inflation" with being those who now urge "the necessity of preparing to stimulate investment again."

The Human Element

Pensions without Temptation

An attempt to devise a pension scheme for a company employing a large proportion of casual labour has been made by John Allan and Company (Glenpark) Limited, a member of the Metal Industries Group. John Allan produce non-ferrous ingots and operate factories in Glasgow and in Oldbury, Staffs.

The scheme is non-contributory and stipulates a waiting period of five years before a workman becomes eligible. The company wanted to avoid any scheme which increased labour turnover, as might have been the case with a contributory scheme where there is a temptation for a worker to leave in order to withdraw his contributions in cash. The waiting period is doubtless devised as an incentive to reduce labour turnover, and pensions when payable will be calculated upon the whole period of service, including the first five years. The pension payable at the age of 65 is at the rate of one shilling a week for each year of service up to a maximum of £2 a week, with a provision for an increase in the event of later retirement. A lump sum to a maximum of £1,095 will be paid on death in service.

It is difficult to assess the chances of any such scheme in achieving its objective. If this is simply to promote the feeling that the company are good employers with a social conscience, there is every chance that it will do so for it will have been launched against a background of good labour relations by an understanding and far-sighted management. Lower labour turnover then becomes a by-product. If, on the other hand, the prime purpose was to reduce the labour turnover, the scheme alone will do little unless it is associated with other measures designed to improve labour relations.

Unions and the Moral Sanction

There is a good deal of discussion at the present time about the power of trade unions and their freedom from the operation of the law in pursuing their members' interests. Lord Denning, Lord of Appeal in Ordinary, alluded to this problem in an address last week to the college faculties of University College, London. He emphasised that the smaller the sanction of law so far as the trade unions are concerned, the greater the moral responsibility towards the community.

There have been a number of efforts made in recent years to organise pressure with a view to legislation to prevent the trade unions from being specially favoured by existing statute law. The circumstances in which some unions have been able to enforce the " closed shop " or send union members to " Coventry " have caused concern among many fairminded people.

The fear of the power of the unions is genuine enough. There has been much talk about them constituting an estate of the realm in their own right. But a counter-force is also becoming evident, given impetus by the recent bus strike in London. The British public is beginning to find that the threat to strike, and even the strike itself, is not such a terrible weapon as some, including union officials on some occasions, have suggested it would be.

Teachers Refreshed

Most teachers experience at some time in their careers the wish to give the lie to George Bernard Shaw and practise what they teach. It applies equally to law dons, medical professors or readers in physics. To most of them it is indispensable to the execution of their art, since to keep in touch at a distance, however assiduously and intelligently done, is no substitute for experience without which all notes of realism can go out of a class or a lecture. It was one of the recommendations of the 1956 Government White Paper on Technical Education that technical college teachers should be encouraged to take refresher courses in industry. An actual experiment in this field is described in an article by Neil H. Mann entitled " Technical Teachers in Industry," which appears in the June issue of *Training*, published by the British Iron and Steel Federation.

Mr. Mann is the organiser of Further Education in Lanarkshire, and his article relates to a system of refresher courses now in operation for two years in his county. Technical colleges are closed for the full two months of July and August instead of re-opening in mid-August as previously. Teachers spend the additional two to three weeks of vacation in industry in order to " study the problems and be able to ascertain the difficulties confronting their students and also learn, at first hand, of the new technical developments in industry which had taken place since they had taken up a teaching career." Industry proves most co-operative; in 1956, 101 teachers were placed " within travelling distance of the county of Lanark." Last year some were placed farther afield, including some English firms. Mr. Mann's conclusions are most hopeful. Many of the teachers have felt it necessary to reconsider the presentation of their subjects, and the contacts they have made in industry have proved most valuable.

The Minister of Education announced last week that technical college teachers are to have new opportunities for full-time training in the principles and practice of teaching. Courses will last ten weeks; tuition will be free and travelling expenses will be paid.

Grants to Students

A committee has been appointed to study the whole question of awards to students out of public funds for the purpose of proceeding to first degree and equivalent level. The present system of grants goes back to the Education Act of 1944. As recently as last month certain relaxations for parents in administering the hardship test were announced. Now the system is to have a more basic overhaul.

The committee under the chairmanship of Sir Colin Anderson will be asked to consider the relaxation of the hardship test, how responsibility should be shared between the central and local governments, whether the State should continue to supplement university and equivalent scholarships, whether there should be special rewards for merit and what should be done for students attending comparable courses at technical colleges.

There are about 80,000 students of undergraduate status in this country and about three-quarters of them receive assistance from public funds. It is estimated that the abolition of the hardship test would cost about £3·5 million a year if local government grants were included. The gist of the case for abolition is that a test which discriminates against higher incomes may add an undesirable burden on conscientious parents who are able to provide the kind of background (not necessarily measured in money terms) from which much of the best undergraduate material comes.

Indian Engineers Classified

Because of India's severe shortage of scientists and engineers, a careful census of qualified trained personnel is being taken. A new system of registration has been devised and the national register of the Council of Scientific and Industrial Research has been re-organised and its scope greatly extended. The new system aims at a more accurate classification of personnel and quicker handling of information. The re-organised register will be expected to provide all the basic information needed for the planning of technical manpower employment and to help in the selection and placement of scientists and engineers. According to an announcement in *India News*, the potential of registerable technical personnel in India is about 120,000.

The concept of manpower planning was first established in India in 1947, and the results obtained were sufficiently encouraging to warrant this new development. An interesting feature of the registration procedure is the special emphasis which will be placed on scientists and technologists trained in foreign countries and on the scholars and trainees who are working abroad.

First Aid in Factories

A great deal of sophisticated writing and talking takes place these days about industrial relations. There are several jargons earnestly dedicated to making the subject intelligible only to the expert. It is consequently all to the good when basic facts jolt us into realising that a few elementary issues about human relations have still to be dealt with. A recent example of this has been the drive started on behalf of the Ministry of Labour to recruit more people to give first aid in factories.

It is one of the shortcomings of our present organisation in factories that all too few of them have a sufficient supply of first aid boxes and personnel who can apply a tourniquet or treat for shock. The extent of the shortcomings was hinted at in the Report on Industrial Health based on a survey of Halifax and published in the spring.

A new draft Order has now been made laying down the content of first aid boxes in factories, and a special drive is to be made to make managements aware of the need to take an interest in first aid. This effort has the support of the employers' organisations, the trade unions and the three big voluntary organisations concerned with first aid.

Ravages of Rheumatism

The severe losses sustained by industry through rheumatic disorders are revealed in the latest statistics compiled by the Ministry of Pensions and National Insurance. During 1957 sickness benefits were paid out to 5,140 workers in the metal manufacture, engineering, electrical and allied industries absent through rheumatism, compared with benefits to 6,300 absent through accidents. The report emphasises that it is only in severe cases that the sufferer is certified as unfit for work and granted sickness benefit: " impaired efficiency among those who remain at work although handicapped by rheumatic pains no doubt causes heavier loss to the industries." According to the British Medical Association, 4 per cent of the whole population are affected.

Details of new aids to overcome rheumatism are given in an announcement by the research department of Ashe Laboratories in Leatherhead, Surrey, who claim to have made substantial progress in effecting relief from pain. A new compound has been developed, named Viodox, which can be taken in tablet form " while at work, for the quick relief of pain or discomfort."

Ashe Laboratories' announcement implies that their work was in some way a follow-up of recommendations contained in the report of the joint committee of the Medical Research Council and of the Nuffield Foundation into the best elements for the treatment of rheumatism. It is encouraging to read of action bearing fruit so quickly following the publication of the results of basic research.

Metals and Materials

BEARINGS KEEP GOING WITHOUT ATTENTION

PTFE Impregnated Bronze

Porous sintered bronze bearings, impregnated with PTFE (polytetrafluoroethylene), answer many design problems where bearings must operate for long periods without replenishment of lubricant, and where oil or grease may be objectionable or unable to withstand relatively high temperatures. Under the name "Polyslip," such bearings are being manufactured by Bound Brook Bearings Limited, Trent Valley Trading Estate, Lichfield, Staffordshire—a member company of the Birfield Group.

Polyslip bearings have a porous bronze matrix impregnated with PTFE, and have a superficial layer of PTFE on the bearing surface. This layer is only 0·0005 in thick and is provided for the running-in period during which the layer of PTFE is transferred to, and forms a thin film over, the bearing surface of the shaft or journal.

When the layer is transferred to the journal, PTFE runs on PTFE, and there is no metallic contact. If a deficiency of the solid lubricant occurs—usually by wearing away of the PTFE film—the local rise of temperature causes expansion of the PTFE in the porous lattice of bronze and it exudes to the surface. Replenishment of lubricant causes the local temperature to return to normal and the film of PTFE on both the bush and journal surfaces is re-established.

There are three types of Polyslip, and each type is available in two different grades, designated A and B. Grade A is fully impregnated with PTFE, while Grade B (intended for less onerous duties), is only part-impregnated, and is substantially cheaper.

Polyslip types are numbered 1, 3 and 4. Type 1 bearings have compacted and sintered porous bronze matrices impregnated with PTFE and, with few exceptions, are available in the same large range of sizes and shapes as the well known oil-retaining bronze bearings made by Bound Brook Limited. They are supplied as plain cylinders or with a single flange, and as thrust washers, and as spherical bearings. Type 1 is recommended where close tolerances are required and where this type of matrix is suitable for the purpose in mind.

Type 4 bearings have matrices made from graded spherical bronze powder which is not subjected to pressure in the moulding (as are the powders used in making Type 1 bearings). After the sintering operation, Type 4 bearings are impregnated with PTFE in the same way as the other types of Polyslip bearing. They are available as straight cylinders or thrust washers. Complex shapes can also be produced by special machining techniques.

Type 3 bearings have been developed to overcome the physical and financial restrictions of the process by which porous sintered bronze bearings are made. They are usually supplied where the bearing diameter exceeds 3 in. They are also available in smaller sizes, and are specified for severe shock or impact loading. Type 3 Polyslip bearings have solid bronze shells or dense sintered bronze backings to provide structural strength, with 0·03 in linings of sintered porous bronze at the working surfaces. These porous linings are impregnated with PTFE.

Research has shown that a rough guide to the performance of Polyslip bearings in any one of the Types 1, 3 and 4 is given by the PN value—the product of the pressure P in lb per sq. in and the shaft speed N in r.p.m.—at which 1,000 hours of life can be expected.

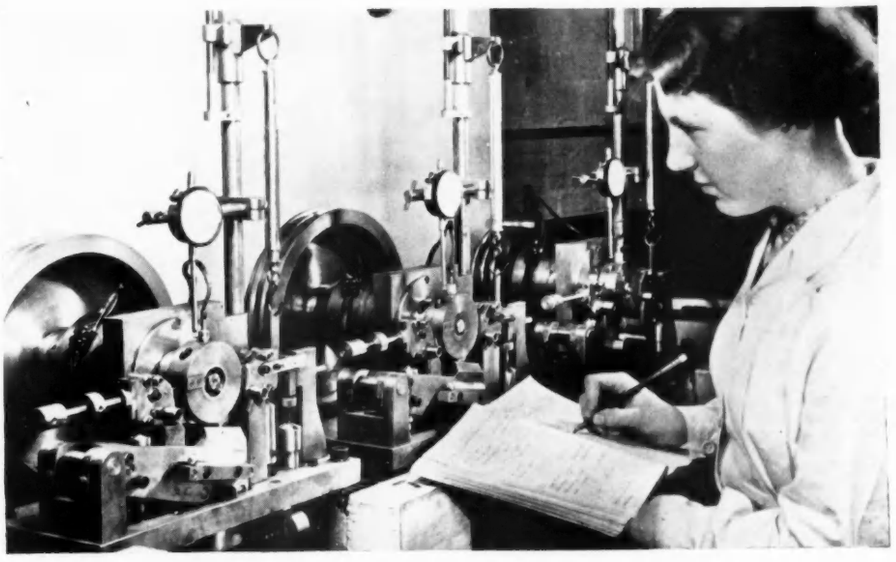
The following figures are averages obtained with Polyslip bearings of various types and grades operated in the absence of any liquid. The life or duty of these bearings is increased by the presence of water or other liquid in which the bearing may be wholly or partly immersed. Polyslip 1, Grade B, 4,000 PN; Polyslip 1, Grade A, 7,000 PN; Polyslip 3 and 4, Grade B, 14,000 PN; and Polyslip 3 and 4, Grade A, 18,500 PN.

Certain substances, used as additives, have the ability to lengthen the life of a bearing impregnated with PTFE and Bound Brook Limited have a continuing programme of research directed at evaluating the influences and suitability of these substances.

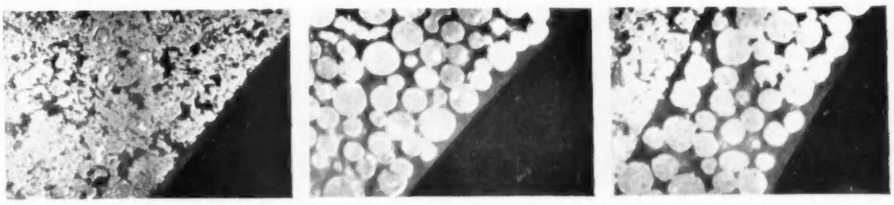
Because the PTFE impregnated bearings are necessarily more expensive than oil-retaining bearings, they are offered as specialised components to be used where oil lubrication is impossible or undesirable. They have applications in motor manufacture, mechanical handling, textile manufacture and treatment, paper making and printing, and the manufacture of fractional horse-power motors, especially for use at high temperatures.

Bound Brook Bearings Limited have received completely satisfactory reports on Polyslip bearings used in diverse applications; for example, in water pumps, and in fuel pumps handling kerosine, where the bearings operate in the fluids handled. Not immersed, they are giving excellent performance in domestic appliances, road sweeping vehicles and dust exhausting systems, as well as in gearboxes used by the Atomic Energy Authority.

Success under these demanding and sometimes onerous conditions has led to the trial of Polyslip bearings in many other applications where their specialised properties will be beneficial: such as in artificial limbs, knitting machines, tape recorder guides, radio and electronic equipment, clocks, fan motors operated in high ambient temperatures, and large mixing kettles for the preparation of chemicals. All these are applications where apparatus is required to operate for long periods without attention, or where the conventional lubricants could not withstand the operating conditions imposed.



Bearings being tested to determine the progress of wear under pre-set loads in the laboratory of Bound Brook Bearings.



Polyslip 1 **Polyslip 4** **Polyslip 3**

Photomicrographs of sectioned Polyslip bearings.

CENTENARY OF BESSEMER STEEL IN SWEDEN

In their classical text-book on *The Metallurgy of Steel*, Mr. F. W. Harbord and Mr. J. W. Hall state that "To Sweden belongs the honour of having first carried out the Bessemer process on a commercial scale." The authors add that "in the early experimental days Sir Henry Bessemer was of the opinion that high pressure of blast was the important factor, and it was not till G. F. Göransson adopted a large tuyere area, thus securing an abundant air supply with corresponding shortness of the blow, and, at the same time increasing the temperature of the bath, that successful results were obtained." The first satisfactory blow by Göran Fredrik Göransson, using the new technique, was carried out in a fixed converter in July, 1858 (two years after Bessemer's announcement of his invention) at Edsken, some 10 miles west of Sandviken, and the steel ingots were conveyed from there to the Högbo Forge situated on the outskirts of Sandviken. In 1862, Göransson founded the Sandvik Steel Works, now the Sandvikens Jernverks A/B., which has recently erected monuments at Edsken and Högbo. The original blast furnaces have been restored and, in front of them, a replica of the old converter has been placed on a stone pedestal. This is to be unveiled on July 18.

Talking to Americans

AMERICA IS STILL GOING PLACES

Following an introductory article entitled I Like Americans (6 June), ENGINEERING is publishing a series of reports under the general heading America is Still Going Places. The Territories (13 June) presented a brief impression of the country together with a study of the current business recession; The Trails (20 June) discussed five perspectives in American thinking. Last week we published The Frontiers—in management and education—and this week continue with The Frontiers—in engineering and research. A summary and assessment, Beyond the Frontiers, will conclude the series next week. The reports are being prepared by Mr. E. P. Ward, a deputy editor of ENGINEERING, who, following a visit to the Soviet Union last year, has recently toured the United States.

THE FRONTIERS—2

Pattern of Research

THE future strength of an industrial nation depends on the research it carries out to-day. It is important to consider not only the quality and extent of this research, but also the manner in which it is organised and the success with which it is applied.

What appeared to me the most distinctive feature of United States research was the refusal of any one institution to specialise in a single field. Thus the Naval Research Laboratory in Washington included in its programme not only applied research concerning corrosion of metals in a saline atmosphere but also basic research in radio astronomy and thermonuclear plasmas. The same was true of the independent research institutions, like the Battelle Memorial Institute, Arthur D. Little Incorporated and the National Research Corporation, and also to a great extent of the industrial laboratories, such as those controlled by General Electric, Westinghouse, RCA and du Pont. Even aircraft companies like Convair, whose interests were likely to be more restricted, covered a wide spread of research problems.

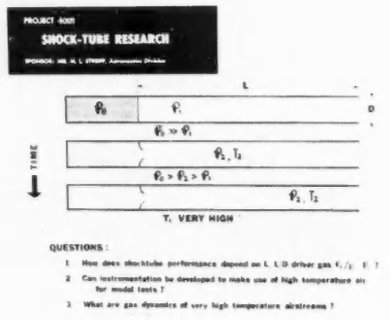
Perhaps a clue to this distribution of activity is given in a remark by Dr. James R. Killian, Jr., president of MIT and technical and scientific adviser to President Eisenhower, who writes in *Technology Review:* " in pointing out areas which may need more emphasis and support, we must not forget that the direction and course of science is largely determined by the imaginative individual scientist following his own interest." The benefits of the broad mandate include an immensely fruitful interchange of ideas by workers belonging to the same institution, and access to a far wider range of experimental techniques. Equally important is the possibility of making a multiple-discipline attack on any problem, a requirement met in the Soviet Union by means of temporary research commandos. But in general, the research institutes of the U.S.S.R., whether industrial or controlled by the Academy of Sciences, appear to be specialist in designation.

Dr. Killian also observes: " We have come to think of basic research as finding its natural home in the university, and indeed the university seems the best instrument for conducting basic research. This has not always been true, and we may well be entering a period when other forms of organisation will compete with the university in the field of basic research. A few great industrial laboratories have strong basic research programmes and an increasing number of Government-operated or Government-sponsored laboratories conduct basic research, as indeed they should and must." The way in which research, whether basic or applied, has extended beyond the universities can perhaps best be indicated by considering a number of different laboratories in turn and reporting their work and the comments of their officers. I was told that the total expenditure on basic research in the United States in 1957 was 22½ million dol, half of which came from private sources.

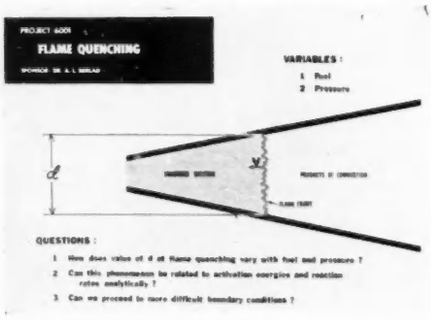
At Battelle I learned that there were broadly five kinds of research organisation in the United States. Firstly there were the company research departments, of which there were some 4,000. Secondly there were Government-supported laboratories, such as those associated with the Department of Agriculture and National Advisory Council on Aeronautics, of which there were about 300. University research foundations, which employed some full-time people, provided the third kind; and trade association laboratories the fourth. Finally there were the independent institutions, of which there were about 10, Battelle, I gathered, being the largest, engaged almost entirely on sponsored research. In addition there were laboratories which, though largely independent, were associated with universities, such as Stanford Research Institute and the Armour Research Institute, which has a link with the Illinois Institute of Technology

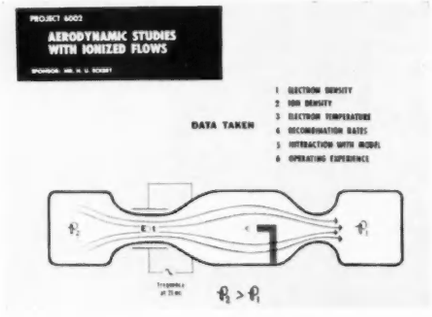
Sponsored Independent Research

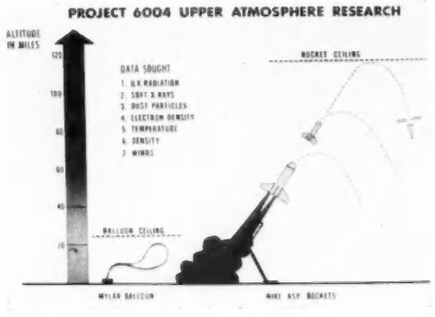
Battelle itself was an endowed institute founded 29 years ago. It employed some 2,400 people, of which 40 to 45 per cent were graduates, and preferred to recruit people with 4 or 5 years' industrial experience, though some came directly from college, as did their foremost specialist in plastics. The institute undertook research on problems submitted by companies, who would receive an initial estimate for cost and the time required. The results would be the exclusive property of the company concerned and payment would be made on a monthly basis. The institute would also be responsible for putting the results into operation. Choice of institute would be made on grounds of special experience; thus Stanford had to some extent special knowledge of economics, and the Mellon Institute had a bias towards chemistry, though, as previously explained, all these institutes cover a broad range of disciplines. Indeed, Battelle itself had carried out consultant work on diversification, which involves economic considerations, and on petroleum additives in the chemical field. A whisky manufacturer—presumably Bourbon—wished to diversify, and for some reason favoured



Research projects undertaken by Convair







titanium; Battelle recommended stock feed, pharmaceuticals and anti-biotics as more appropriate products. Battelle conducted research in chemistry, metallurgy, physics, fuels and combustion, ceramics, mineral processing, chemical engineering, mechanical engineering, electrical engineering, petroleum technology, electrochemistry, plastics, rubber and paints, electronics, theoretical and applied mechanics, nucleonics, welding technology, graphic arts, reactor technology, agricultural sciences and economics, but, unlike Arthur D. Little, for example, did not undertake consulting work.

Battelle and Mellon represented two different approaches to the multi-discipline project. At Battelle, a group of specialists working in different fields consult together in a temporary

What They are Thinking and Where it Leads

combination; whereas at Mellon, the specialists form a semi-permanent team which is virtually hired for the job. Both institutes recognise the increasing importance of fundamental work; and indeed the vice-president of Battelle remarked that the distinction between applied and basic research was unreal. Battelle had recently carried out some fundamental physical and metallurgical studies in connection with pipelines and for an expenditure of 100,000 dol had saved a total of 170 million dol. Battelle was broadening its work as much as possible and now covered some 50 major fields including cancer research.

The Mellon Institute has recently altered its structure so that it can direct its principal investigations towards long-range fundamental research. The new structure is shown in the diagram above. The primary objective of the change is to free the creative research scientist from administrative demands while providing the most in service facilities. Applied research in selected fields will continue along with fundamental research of an unrestricted nature. "The imperative need for more active replenishment of the reservoir of scientific knowledge through fundamental research is widely recognised," states the institute, "yet the progress of fundamental science has seriously fallen behind the proliferation and consequent requirements of applied science and technology." The Mellon Institute is an endowed non-profit-making corporate body for conducting comprehensive investigations on important problems in the fundamental and applied natural sciences, for training research workers, and for providing technical information adaptable to professional, public, and industrial advantage.

Though having ample resources for fundamental and applied research, Arthur D. Little Incorporated is primarily a consultant organisation, concerning itself with almost any problem touching on technology that might be met in business. It is also operated for profit. Founded in 1886, ADL exists "to apply the knowledge and methodology of science to the solution of practical problems wherever they may arise in our complex industrial society, and to discover and help our clients to exploit new opportunities for growth." It is in this form of organisation that the Soviet Union appears to be most seriously lacking.

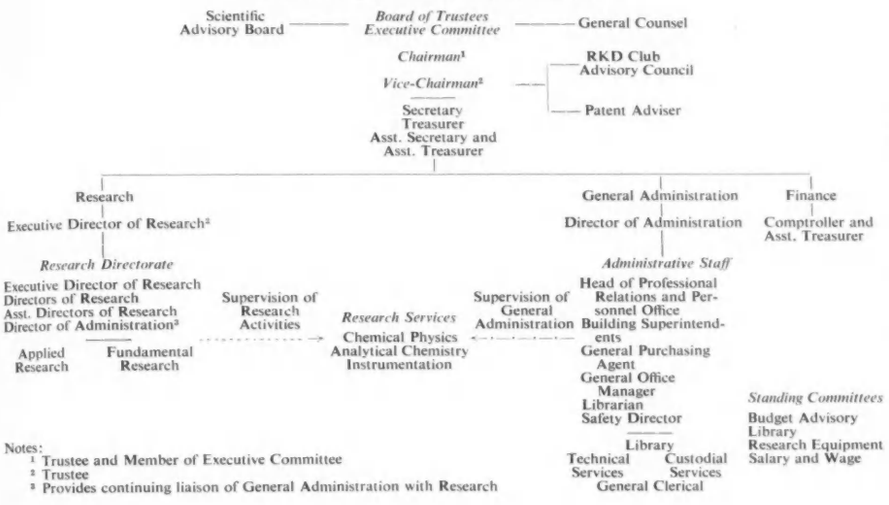
Ranging over the entire field of technology and employing a staff of 800, ADL supplies companies with both information and advice—for example, on introducing automation, finding new markets or improving existing products. It has special experience in integrated commercial development, guiding a complete project from idea to commercial reality. Patent development, invention management and expert legal testimony are other fields of interest. In addition to engineering (cryogenics to missiles) and science (biochemistry to nucleonics), ADL has experience in the field of technical economics, tackling problems of project analysis or complete industrial surveys. For this reason, besides laboratory and technical departments, there is a group concerned with management and business services, which engages in operations research, area development studies and advice on investment. The operations research branch makes use of the organisation's extensive computer section, devising mathematical models for inventory control or other business situations. Area development studies have been undertaken in Puerto Rico, Honduras and the County of Los Angeles, where integrated schemes based on the areas' resources or requirements have been evolved.

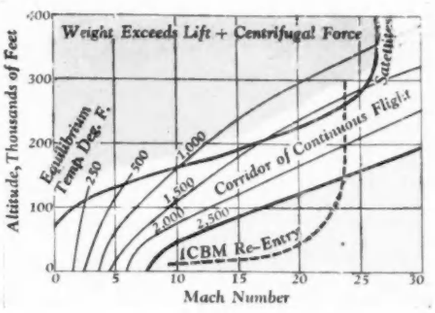
Arthur D. Little is engaged both in continuing research and subcontract research, working on weather control at its own expense, or developing a special-purpose glue for a customer. It has a loose administrative structure allowing considerable flexibility and accepts it as a principle that no field of technology exists in isolation. Thus it may even be of service to a major industrial research laboratory, in that it has, for example, biologists and financial specialists on its staff. Nuclear Metals Incorporated, concerned with materials research, is partly owned by ADL, which does not in general, however, favour the creation of subsidiaries to develop its discoveries, since it has no wish to set up in competition with its clients. An Arthur D. Little laboratory has been established in Scotland.

The National Research Corporation, on the other hand, has as its objective "the creation of new commercial enterprises through the application of scientific research backed by careful market survey and close technical management." Generally its fields of activity have included the development of new processes, products and equipment in the metallurgical, petrochemicals and applied physics fields; dehydration and coatings are other areas of interest. Unlike conventional consulting or commercial research organisations, NRC has comparatively few clients and does not undertake to offer services in solving problems in widely divergent fields.

Research programmes are normally conducted on three different bases. Firstly, using its own funds, derived from royalty income and profits from operating divisions and affiliates, NRC undertakes exploratory research in fields of interest to the company. Secondly, in partnership with industrial organisations, research and development work is conducted under terms in which the results of the work are owned jointly by NRC and its partner. Or thirdly, in scientific fields where NRC has unusual experience and facilities, projects are undertaken on a contract basis for industry as well as Government agencies. Over the past five-year period, total research expenditures have amounted to between 40 and 50 per cent of the company's net sales. Among

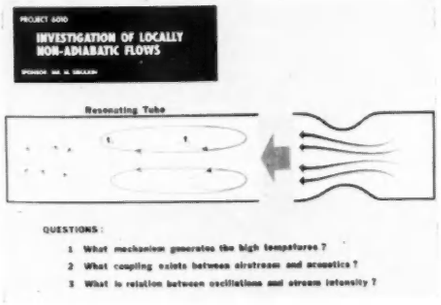
Revised Organisation of Mellon Institute

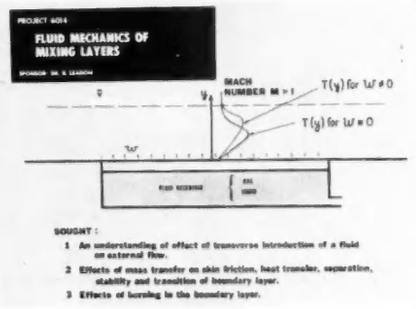


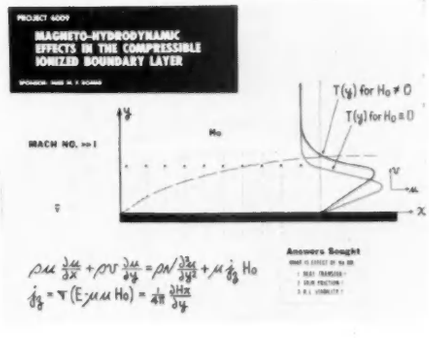


The region in which continuous flight is thought to be practicable as indicated by a Convair chart.

Dynamic heating has proved a less formidable problem than was once expected: nose cones have suffered less damage on re-entry than was anticipated, possibly because heat is taken up by the ambient air rather than by the vehicle. Ionisation and dissociation of the air, providing several degrees of molecular freedom, serve to absorb much of the energy produced, while insulating sprays have reduced the heat-transfer coefficient of the aircraft skin.


PROJECT 6010
INVESTIGATION OF LOCALLY NON-ADIABATIC FLOWS
Resonating Tube
QUESTIONS:
1 What mechanism generates the high temperatures ?
2 What coupling exists between airstream and acoustics ?
3 What is relation between oscillations and stream intensity ?


PROJECT 6014
FLUID MECHANICS OF MIXING LAYERS
MACH NUMBER M > 1
T(y) for ω ≠ 0
T(y) for ω = 0
SOUGHT:
1 An understanding of effect of transverse introduction of a fluid on external flow.
2 Effects of mass transfer on skin friction, heat transfer, separation, stability and transition of boundary layer.
3 Effects of burning in the boundary layer.


PROJECT 6009
MAGNETO-HYDRODYNAMIC EFFECTS IN THE COMPRESSIBLE IONIZED BOUNDARY LAYER
MACH NO. >> 1
T(y) for H₀ ≠ 0
T(y) for H₀ = 0
Answers Sought

Talking to Americans

the companies established are the Columbia-National Corporation (half interest), which is under contract to supply the United States Atomic Energy Commission with reactor grade zirconium; the Vaculite Corporation (half interest), which manufactures metallised papers and plastics; and the NRC Equipment Corporation (wholly owned), which makes vacuum furnaces and similar plant. In addition to wholly and partly owned subsidiaries, NRC pursues its business by selling licences.

Company Research

The functions of laboratories controlled by manufacturing companies are necessarily somewhat more circumscribed, but the areas covered are still extensive. Reference will be made to the organisation of research in four companies.

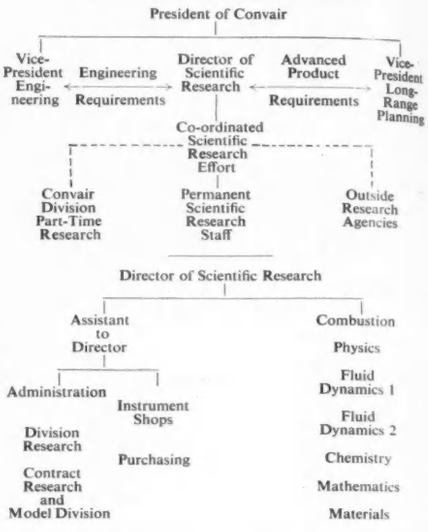
Convair, a division of the General Dynamics Corporation, pursues, in addition to applied research, a threefold scientific research programme. First, there is a permanent full-time scientific research staff in the company's general offices under the director of scientific research; second, scientific research projects are sponsored at universities and at Government and commercial laboratories; and third, provisions are made for personnel in Convair to engage in a scientific research on a part-time basis.

The full-time research staff are given their heads on the understanding that pure research cannot be closely directed, though they may be called upon to solve engineering problems that have proved intractable at the empirical level. They are nevertheless isolated from the company's day-to-day commitments. It is also their function to select long-range problems for subcontracting. Some 55 per cent of the scientific research budget is expended on full-time research of this kind. Another 5 per cent is devoted to the work subcontracted outside Convair, including payments to a staff of over 20 scientific consultants, scientists of the calibre of Dr. Edward Teller. Subcontracted research not only makes additional talents available to Convair, but also serves to foster good relations with universities and other institutions. Typical of the studies pursued on this basis is the problem of shielding airborne nuclear reactors.

The third approach, which absorbs 40 per cent of the research budget, represents an interesting innovation. Competent scientists engaged in applied work who stumble on some fundamental problem may apply to be temporarily withdrawn from their normal duties in order to investigate the problem that has aroused their interest. A case of this kind was a study of the shock-wave phenomena occurring when missiles travel up to and above Mach 20. Since the air traversed by a projectile moving with this velocity dissociates and ionises, it is no longer a perfect gas and no theory previously existed for air flow round a missile in these conditions. Besides being a source of new ideas, this practice helps Convair to retain their qualified and imaginative employees and keeps them in touch with the latest developments. The areas covered by scientific research at Convair are gas dynamics, aerodynamics, metallurgy, theoretical and experimental physics, physical chemistry and mathematics; and examples of problems being tackled are shown in the diagrams on the previous pages. The organisation of research is indicated by the table on the right.

Parallel to the scientific research effort is a centralised applied research programme for all four divisions. Since the programme includes both company and Government-sponsored development studies together with closely related production work, it is necessary to find an approach reconciling these various activities. It is considered that the company's own research offers a better rounded programme, and Government research is therefore fitted into an overall scheme, which though orientated to national requirements, provides adequate continuity. Research is pursued in a stepwise manner to allow rephasing with the central programme.

Organisation of Research at Convair



The General Electric Company has three centralised laboratories, one concerned with basic research, one with general engineering, and the third with manufacturing services. Other laboratories are associated with many of the company's 100 or so production departments. The organisation of the main research laboratory devoted to fundamental work is indicated in the table on the facing page. The mechanism for ensuring the efficient application of research can be seen in the final column. The project analysis section is responsible for preparing an economic assessment of any proposed research project to

(Below) Douglas Thor intermediate range ballistic missile rising from its launching pad.

Though Douglas carry out extensive research and development work, they pursue only those ideas that can produce weapons systems without further invention. Associated with this philosophy is the decision to dispense with prototypes and test vehicles, in both the civil and military fields, and to tool and produce right from the inception of a project. In this way delivery delays are minimised. Optical tooling using closed-circuit television is said to have reduced tooling time by 25 per cent.

(Above) Levitation melting, a technique developed by Westinghouse for high-purity metals.

The metal, originally in the form of a compressed metal powder, is heated, supported and stirred by a high-frequency current carried in a coil; the temperature can be raised to some 5,000° F in half a minute. An alloy, Nictrotung, for use in gas-turbine blades, said to be capable of retaining its strength at temperatures up to 1,800° F, has also been developed in Westinghouse laboratories. Another development is an experimental display screen no thicker than a picture frame which is expected to bring nearer the flat wall television. It combines an electroluminescent panel or light amplifier with a flexible built-in storage and control structure of ferroelectric materials. Light amplification has been used by the Radio Corporation of America to give increased contrast in medical X-ray viewing, thereby reducing the necessary exposure period for the patient.

(Below) Versions of a thermionic converter built at the General Electric research laboratory.

Devices of this kind have converted 8 per cent of heat energy supplied directly into electric power. Another G.E. technique, related in principle to a diffraction grating, employs a special projector for converting colour information recorded as tiny ripples on a clear gelatin film into a coloured picture. Tolerance to temperatures of 900 to 1,500° F and to nuclear radiations is claimed for electronic components developed by G.E. and employing such materials as ceramics and titanium.

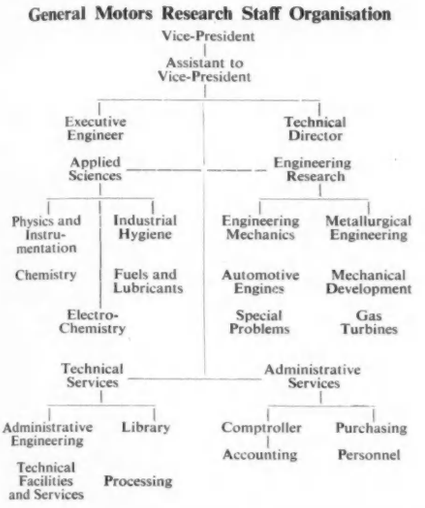
What They are Thinking and Where it Leads

determine whether or not its potential value is commensurate with the estimated cost. Thus before a detailed study of solar energy was undertaken, costs, applications and technical and economic considerations were thoroughly examined. The operation analysis section is concerned with administrative procedures and also with Government contracts.

The General Motors Corporation carries on a comprehensive centralised research programme at its technical center, near Detroit, to which reference has already been made. The table below shows the manner in which research is organised in four main divisions.

E. I. du Pont de Nemours and Company,

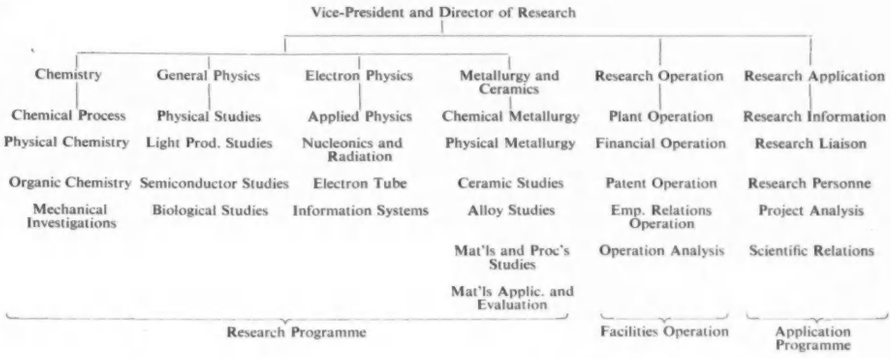
General Motors Research Staff Organisation



being concerned essentially with materials, have enormous scope for research of a basic kind. Last year the company spent 15 million dol on their programme of fundamental research, a considerable proportion of which was carried out at the experimental station on the Brandywine River. The eleven divisions of the company referred to in an earlier article also have associated laboratories staffed in part by members of the chemical department.

The company divides its research into three categories: improving existing processes or products; developing new processes and or products; and fundamental research. Though some 15 per cent of the total research is of a fundamental nature, it is emphasised that this

G.E. Research Laboratory Organisation



Research and Development Costs Financed by Federal Government and by Industry in the United States, 1953 and 1956

Industry	1953		1956	
	Millions of dols	R & D costs financed by Federal Government as per cent of total R & D costs	Millions of dols	R & D costs financed by Federal Government as per cent of total R & D costs
Total industries	1,357·3	37·1	3,134·4	48·6
Chemical and allied products	8·9	2·5	13·3	2·6
Petroleum products and extraction	8·2	5·6	5·1	2·0
Primary metal industries	4·5	7·6	2·6	3·0
Fabricated metal products and ordnance	32·7	31·6	49·1	27·9
Machinery	57·2	17·9	252·5	41·4
Electrical equipment	404·0	54·4	711·6	60·6
Aircraft and parts	639·8	84·4	1,812·2	87·2
Professional and scientific instruments	76·8	44·7	98·9	36·3
Telecommunications and broadcasting	58·9	52·2	74·1	43·3
All other industries	66·2	7·4	115·0	10·3

figure is not necessarily appropriate to other situations. Research budgeting is carried out " synthetically " so that each item of proposed expenditure derives from a specific condition such as need or opportunity for quality improvement, process improvement, new processes, new products, or new uses. " For the convenience of management and to provide perspective, it is helpful to summarise the proposed expenditures according to product groups, and also according to such purposes as : strengthening the competitive position of established products; development of new products; and exploratory work without reference to immediate commercial objectives."

Government Research

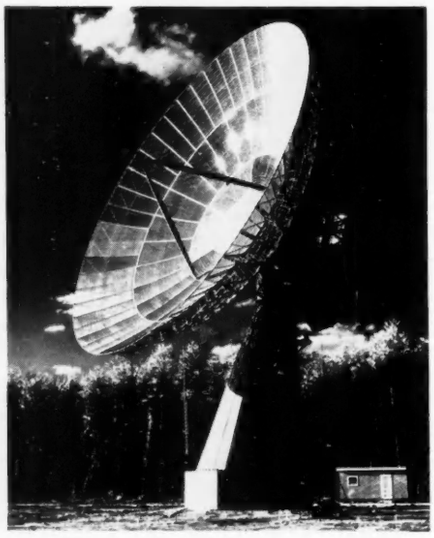
Government research has in characteristic American fashion been left until last, but its contribution is now roughly half of the total national effort, as may be gathered from the table above, published by the National Science Foundation. The Naval Research Laboratory is said to carry out more fundamental research than any other laboratory operated by the Department of Defense, and roughly one-third of the budget is devoted to basic studies, one-third to closely directed applied research, and one third to development. Development is carried out up to the " breadboard " prototype stage, whereupon it is taken over by industry. Funding is provided by an annual lump sum which the laboratory can distribute as it wishes. The laboratory's organisation is illustrated in the chart on the next page.

The National Bureau of Standards of the Department of Commerce is concerned with more than measurement. As its director has pointed out an " agency capable of providing competently the necessary standards for physical measurement is in a somewhat unique position to provide a number of other related and important services to science and industry." The

Single-lever control of a car is provided by General Motors electro-hydraulic Unicontrol system.

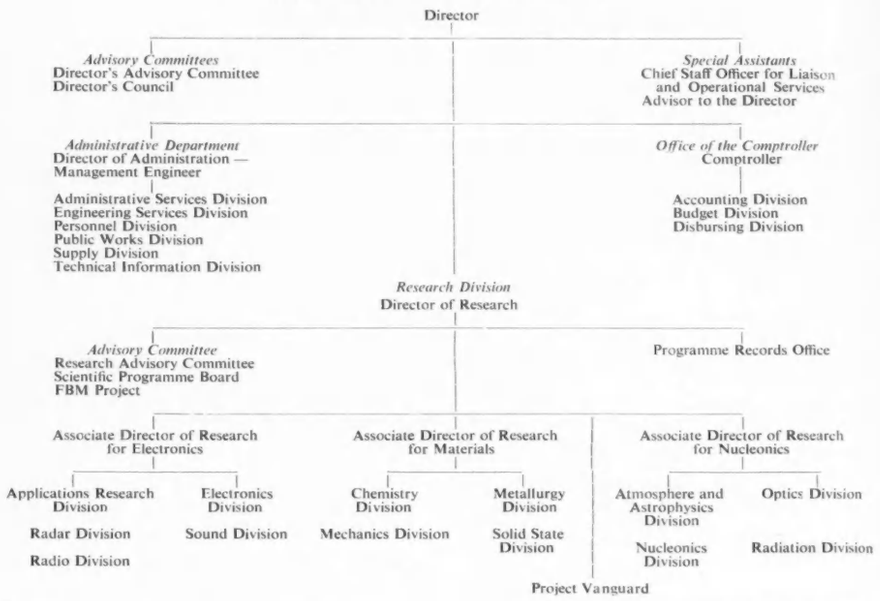
Left and right motion of the weighted knob steers the car, forward motion accelerates it and backward motion applies the brakes. Automatic guidance is also under investigation at the General Motors technical center. The vehicle is steered with reference to a current-carrying cable set in the pavement. Tuned pick-up coils on the car's front bumper feed in voltage variations to an electronic computer, which gives command signals to the vehicle's modified power steering unit. RCA have carried out similar experiments on a 400 ft stretch of public highway in Nebraska.

Talking to Americans—What They are Thinking and Where it Leads



The Naval Research Laboratory's 84 ft radio-telescope at Maryland Point: Official United States Navy photograph.

Naval Research Laboratory Organisation



NRL pursues an enormous range of research projects including a high proportion of fundamental studies. Work includes research on thermonuclear plasmas employing a novel H-tube apparatus; the application of cryogenics to inertial guidance systems; the achievement of high signal to noise ratio in temperature investigations of planets; the discovery of a technique for coating rifles, periscopes and other items with Teflon in order to repel sand and water; and the study of weather. Weather control is receiving considerable attention in the U.S. at present.

general functions of the National Bureau of Standards are (*a*) development and maintenance of the national standards of measurement, and the provision of means for making measurements consistent with those standards; (*b*) determination of physical constants and properties of materials; (*c*) development of methods for testing materials, mechanisms, and structures, and the making of such tests as may be necessary, particularly for Government agencies; (*d*) cooperation in the establishment of standard practices, incorporated in codes and specifications; (*e*) advisory service to Government agencies on scientific and technical problems; and (*f*) invention and development of devices to serve special needs of the Government. It has a considerable number of scientific divisions to carry out this work, including divisions concerned with low-temperature and nuclear research.

Space Research

Naturally in an article of this kind it is impossible to mention all the areas of research in which work is being pursued, but space exploration and the military significance of missiles have lent new dimensions to the concept of flight. It may therefore be appropriate to quote part of a statement prepared by President Eisenhower's Science Advisory Committee giving reasons for undertaking an extensive space programme. A suggested timetable for space research is also reproduced. Contracts have recently been issued for the development of a manned space craft, which, it is said, will be launched liked a rocket, orbit like a satellite, and return to land like a conventional aircraft—a flight pattern known as dynamic soaring. Project Dynasoar will be the first step towards a manned space vehicle. A study published in *Aeronautical Engineering Review* concludes that even using chemical fuels it will be possible to put a manned satellite into orbit within 25 years at a cost lower than one billion dollars. In the context of intercontinental missiles it is interesting to note that the relative geographical positions of say Washington and Moscow are not yet known with sufficient accuracy to permit a satisfactory strike, no matter how accurately the missile itself can be directed. The Advisory Committee's reasons for pursuing space research are as follows.

"It is useful to distinguish among four factors which give importance, urgency, and inevitability to the advancement of space technology. The first of these factors is the compelling urge of man to explore and to discover, the thrust of curiosity that leads men to try to go where no one has gone before. Most of the surface of the earth has now been explored and men now turn to the exploration of outer space as their next objective. Second, there is the defense objective for the development of space technology. We wish to be sure that space is not used to endanger our security. If space is to be used for military purposes, we must be prepared to use space to defend ourselves. Third, there is the factor of national prestige. To be strong and bold in space technology will enhance the prestige of the United States among the peoples of the world and create added confidence in our scientific, technological, industrial and military strength. Fourth, space technology affords new opportunities for scientific observation and experiment which will add to our knowledge and understanding of the earth, the solar system, and the universe. The determination of what our space programme should be must take into consideration all four of these objectives."

Objectives of Space Research

Early	Later	Still later
1. Physics	1. Astronomy	1. Automated Lunar exploration
2. Geophysics	2. Extensive communications	2. Automated planetary exploration
3. Meteorology	3. Biology	3. Human Lunar exploration and return
4. Minimal Moon contact	4. Scientific Lunar investigation	*And Much Later Still:*
5. Experimental communications	5. Minimal planetary contact	Human planetary exploration
6. Space physiology	6. Human flight in orbit	

Mr. Louis Polk, president of the Sheffield Corporation, has pointed out: "Our progress continues to be limited by our ability to split the inch into smaller and smaller portions." Likewise it depends on the discovery of new materials and the modifications of existing ones. But if success in these directions is not accompanied by efficient organisation of research and the rapid dissemination and application of its results, much effort will be wasted. The Russians have been highly systematic in their research planning, but appear to have left little scope for flexibility. Since research—as Dr. Killian has said in other words—tends to follow its nose, the Americans may have a temporary advantage in the variety of their institutions. In that they are clearly giving considerable thought to the proper management of research they may press the advantage home.

The du Pont Company's Experimental Station.

Horizontal silos, temporary shelters for railway wagons and even comparatively large structures supported by air pressure have been made from such synthetic fabrics as Neoprene coated Nylon. A photosensitive polymer for printing plates has also been developed. But plastics are by no means the only products of du Pont research. Lysine, a valuable protein, which, added in quantities of one quarter per cent, can raise bread to the nutritive value of meat and eggs, can now be derived from such by-products as furfural and bagasse.

Marketing

CAPITAL FOR THE COMMONWEALTH

Increasingly there is talk of inadequate resources in Commonwealth countries to develop their economies on the lines they have planned. India in particular has suffered from lack of funds and also, one suspects, lack of borrowing power in the world's money markets. Australia, New Zealand, South Africa, Ceylon and even Canada suffer from the same basic troubles.

There are two main causes of this seemingly universal trouble. The first and the most basic is the tendency to plan the expansion of secondary industry—for example, engineering and metal industries—ahead of local needs and therefore without the existence of a demand level adequate to sustain efficient production. The second is long established and obdurate but not the result of local policy; rather it is the product of the world's inability to adjust its flow of trade to a stable and predictable level. Fluctutions in the prices of raw materials and primary products generally have caused much hardship in countries such as Australia, Canada and New Zealand. Like traffic on a main highway, it takes but a minor accident to produce a blockage taking hours to remove. The threat of war in the Middle East led Europe, Britain and the United States to stock up imported commodities. When the Canal was reopened and the threat of a major conflagration receded, buying almost ceased. The effect of this was a tumble in most commodity prices and few good buyers would enter a falling market. Hence the sustained recession in world trade, and particularly in trade between Commonwealth countries and their two main customers, Britain and the United States.

The effect of such a recession on the export of British capital goods is well known. Ultimately, it could trigger off a world-wide slump. Apart from establishing an international control on commodity prices, as is being done by some industries, such as zinc, the only remedy lies in supply of capital adequate to offset the shortfall in foreign currency earnings. A good example of this is Canada, where the influx of large quantities of United States capital has made possible continuous and rapid industrial growth since the war. There are many problems which the borrowers, and also the lenders, have to face. One is safety of investment: private capital is not easily attracted to areas unsafe politically where risks are thought to be high. India and Egypt are not over-attractive. Government loans are not a complete solution, nor are semi-official lenders such as the World Bank. Politically, much of the British Commonwealth is a safe area for the private investor but not necessarily as attractive to the United States industrialist as Brazil, Mexico or other American countries where the United States political influence predominates.

During the next five years most Commonwealth countries will be seeking foreign capital, if only " to maintain the flow of essential imports at a measure commensurate with full employment." These words are quoted from a statement by Mr. Nordmeyer, finance minister of New Zealand, in that country's *Economic Survey* published last week. There was a deficit of £56·2 million in New Zealand's exchange transactions for the year ended 31 May. South Africa's minister of economic affairs, Dr. A. J. van Rhijn, said that his country wants foreign capital and wants it to come " without any worry that it might be forcibly domiciled." One of the South African Government's major self-imposed tasks is that of " creating a satisfactory climate " for overseas investment. Without it there can be no further significant industrial expansion. We reviewed in Weekly Survey last week Canada's capital needs: they are considerable and the chief obstacle to close economic relations with this country. The Commonwealth is not the only area where capital is required to sustain growth. In fact the world as a whole is in the position where industrial growth in underdeveloped countries requires more capital than industrialised countries are able to produce over and above their own needs. It is against this background of scarcity that Mr. Macmillan discussed in the United States and in Canada possible co-operation by the countries of the West in providing development capital for the Commonwealth.

One of the main conclusions reached at the preparatory talks held in London recently for the Commonwealth Trade and Economic Conference (to be held in Montreal on 15 September) is that the Commonwealth is no longer capable of ordering its economic affairs in isolation. Neither its short-term nor long-term capital needs can be met without outside assistance. It is in this context that Germany's possible contribution is discussed in the following note.

Western Front of Investment

Germany has begun to play a part in the financing of world trade and appears prepared to invest on a relatively large scale in underdeveloped countries. The Bundesbank (German Federal Bank) recently granted the World Bank a new 75 million dol 2½ per cent credit. Dr. Erhard, the German minister of economics, and Herr Karl Blessing, chairman of the Bundesbank, have met Mr. Eugene Black, president of the World Bank, to discuss possibilities of setting up an international financing association to specialise in credits to newly developing countries. Herr Blessing told the Frankfurt Chamber of Commerce that joint investment by British and German financial groups in Commonwealth countries was a possibility on the grounds, he said, that the British " are more experienced at such investments than we are."

The pressure by German industry for an improvement of facilities in the financing of long-term exports is growing—and so are German foreign currency reserves. Plans are under discussion to make claims of German exporters negotiable by selling these claims jointly with the export risk insurance certificate to the German Reconstruction Bank, which in turn would finance the purchase of such claims by issuing medium-term bonds. A beginning was made in the case of India to finance the deferment of payment for the steelworks in Rourkela. By building up a market for good exporter-claims, credit terms up to 10 years might be granted—as is said to have been done in the case of Egypt.

The Germans appear to prefer this method of export financing to the suggestion of an International Development Association, which would finance projects up to 40 years. In fact they are developing an international hire-purchase business which might be well fitted to strengthen the position of the West in under-developed countries against the developing economic threat from the East.

Brazil's New Capital

The news that the Government of Brazil had decided to build a new capital on the high plateau of Goiaz is an indication of the country's tremendous vitality. Brasilia, as it is to be known, will be an ultra-modern city with a planned population of 500,000, with satellite towns and industrial centres. The climate is one of the best in the country and the area one of the richest in natural resources. Already the foundations are being laid and the airport nearly completed. Road and rail links are well advanced.

The industrial capacity of the country is increasing rapidly and exports of manufactured goods are beginning to make a contribution to the country's balance of payments. But the deficit this year, due to falls in coffee and cotton revenue, is estimated at some 500 million dol, and industrial expansion must slow down (1,380 million dol have been budgeted for imports in 1958) unless substantial credit is secured. Drops in coffee and cotton revenue are the main cause of these difficulties. But optimism abounds and sheer vitality may well secure a solution.

Production Show in Canada

A special attempt is being made by the Board of Trade to make a show of strength on behalf of the British engineering industries at the National Industrial Production Show which is to be held in Toronto from 4 to 8 May next year. The Birmingham Exchange and Engineering Centre, who are co-operating with the Board of Trade, will organise the British display, and co-ordinate the efforts of exhibitors. Stands will be let in units of 120 sq. ft or possibly smaller, at a cost varying from 15*s*. to 45*s*. a square foot.

The exhibition is specialising in production engineering equipment of all types, including tools and machine tools, welding equipment, furnaces, hydraulic controls and instruments. It is the outcome of the Government's desire " to exploit every possible means of expanding trade with Canada " and has for one of its main objects the encouragement of new export business.

Reaching for Dollars

Yet more British companies are taking steps to increase their exports to North America. Mr. D. J. W. Boag, managing director of Rockweld Limited, is personally promoting the sale of their welding equipment and electrodes in the United States and Canada, where they are " comparatively inexpensive." Mr. R. E. Burnett, general manager of Marconi Instruments Limited, is leading an intensive sales promotion campaign which will include taking part in the Western Electronic Show and Convention in Los Angeles in August. Mr. Spooner, Marconi's production manager, will compare United States and British marketing techniques.

A new company, the Molyspeed Corporation, has been formed in Clifton, New Jersey, to organise the sale and distribution of the car engine lubricants made by Rocol Limited, whose range of molybdenised lubricants have made considerable headway in the United States market. Rocol are also conducting a sales drive in Canada where their sales director, Mr. John G. Gershon, has recently established a network of agents. Activities of British manufacturers in that market are increasing, with encouraging success despite the trade recession.

Auckland's Electrical Show

The Auckland Electric-power Board are following up the success of the Easter show of the Auckland Manufacturers' and Agricultural and Pastoral Associations (attendance was over 245,000) with a full-scale electrical exhibition to be held next Easter. A new permanent building will be erected to house the exhibits and the help of various British organisations, including BEAMA, DSIR and the Institution of Electrical Engineers has been sought. BEAMA have agreed to sponsor a historical court in which the progress of electricity and the development of electrical machinery and equipment will be depicted. DSIR, possibly in conjunction with the IEE and other organisations, have been asked to provide a court in which scientific experiments can be demonstrated.

The object of the exhibition is to capture the interest of the general public but there is obviously an opportunity to reach the New Zealand market for electrical plant and equipment.

Construction

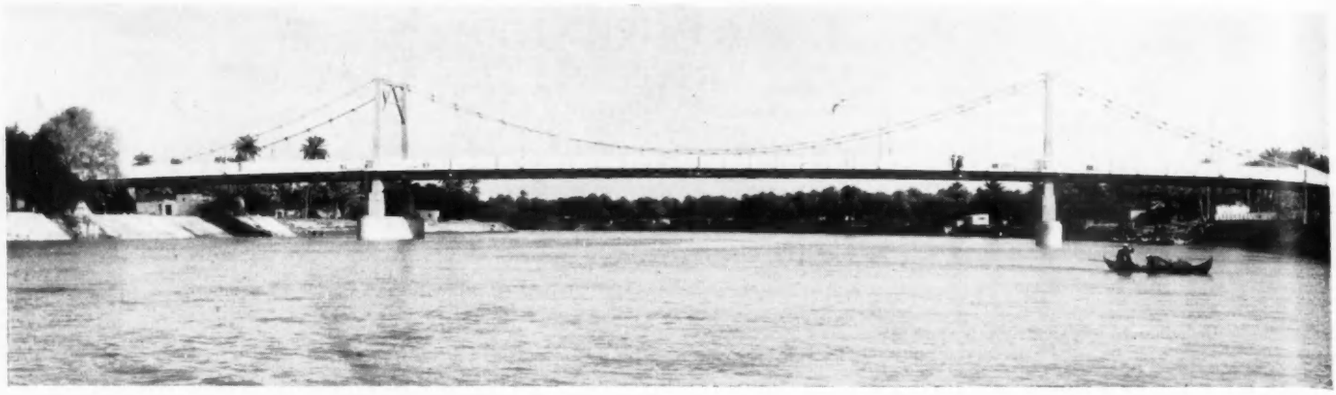


Fig. 1 Iraq's first modern suspension bridge halfway along the trunk road between Baghdad and Basra.

SELF-SUPPORTING SUSPENSION BRIDGE AT SAMAWA, IRAQ

Prestressing Components Used to Anchor the Cables

The first modern suspension bridge to be built in Iraq has recently been completed at Samawa and was opened on 29 April, 1958, by H.E. the Minister for Communications and Works. It is situated on the lower reaches of the Euphrates, about half-way between Baghdad and Basra. It is "self-supporting"—the main girders take the pull on the cables, instead of ground anchors—and the bridge forms an essential part of the western Baghdad to Basra trunk road. Bridges, such as that at Samawa and capable of carrying loads up to 30 tons, are among the new works being promoted by the Iraq Development Board to replace earlier structures which, being limited to loads of two to five tons, are, therefore, no longer suitable for a rapidly expanding country like Iraq. Since 1951, the Development Board has allocated funds for the construction of between 20 and 30 bridges, all over 500 ft long, five of them being sited in Baghdad. The consultant for the Samawa bridge, appointed by the Board to do the design and to supervise the construction, were Posford, Pavry and Partners, of Victoria Street, London.

Major bridge construction in Iraq is greatly influenced by the poor strength of the earth formations. The upper strata of the ground of the central and southern areas of the country were deposited by the double-river system of the Tigris and Euphrates over many centuries and

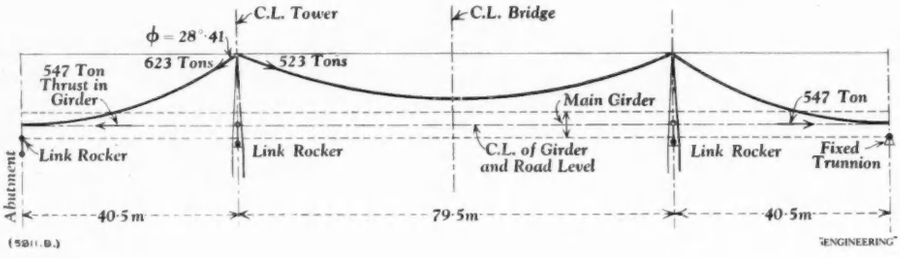
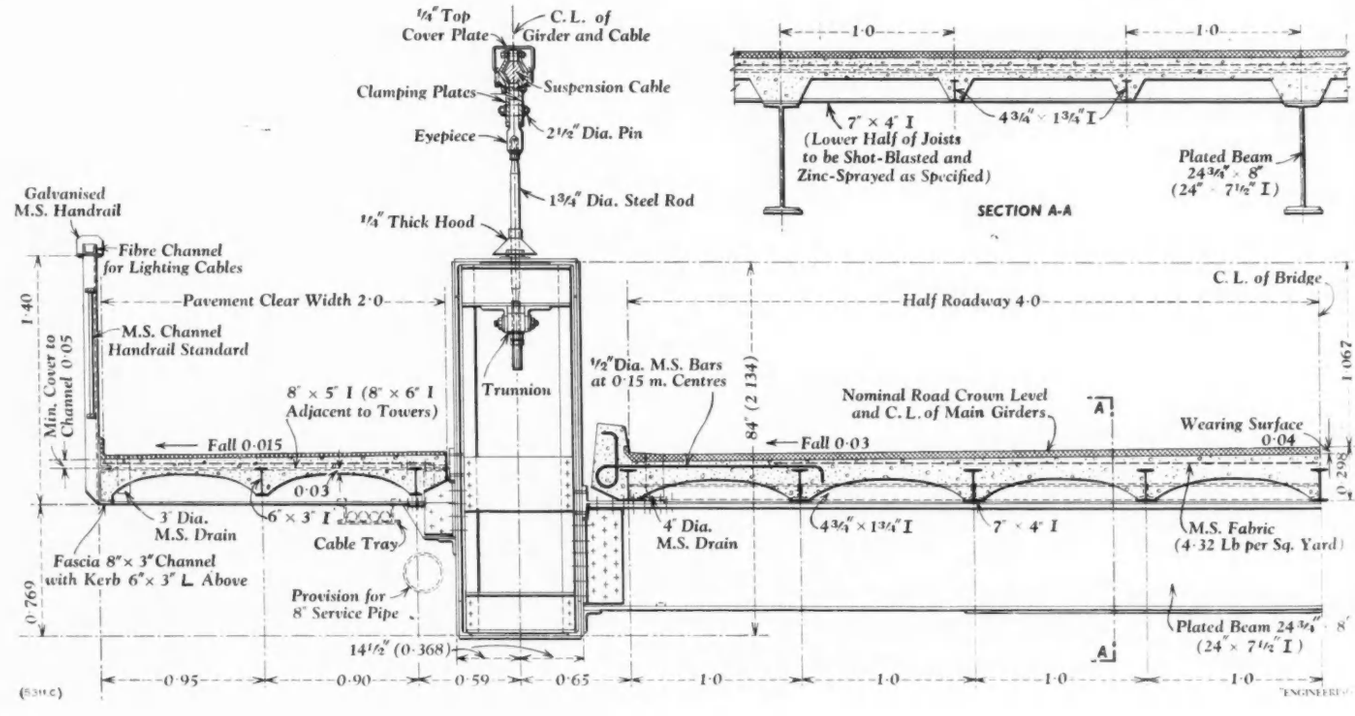


Fig. 2 (left) Force diagram and anatomy of the bridge; the pull in the cables is taken by thrust in the main girders, not by ground anchors.

Fig. 3 (below) Half cross-section of the bridge showing a main girder and suspender, roadway and pavement.



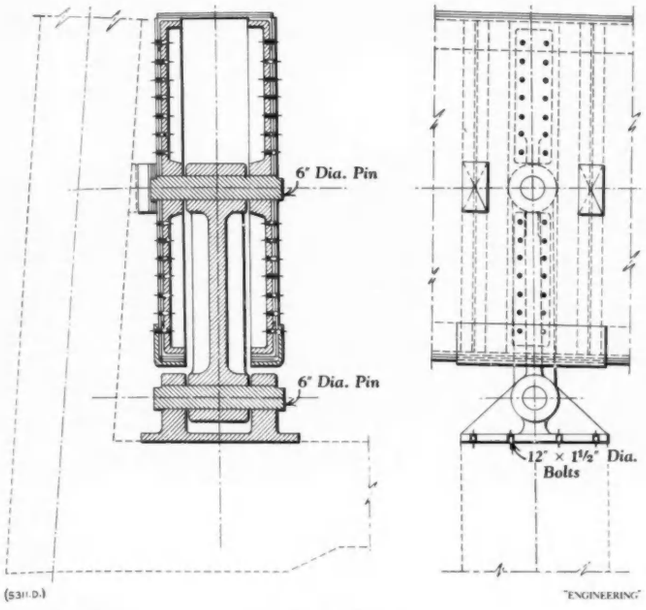


Fig. 4 (left) Intermediate trunnion support at a suspension tower. The links are hinged on the centre lines of the girders and at the lower end are carried on the tower cross-beams. Full allowance is thus made for expansion in the bridge.

Fig. 5 (right) The roadway and footpaths are supported by concrete jack arches which spring from a grid of structural steelwork.

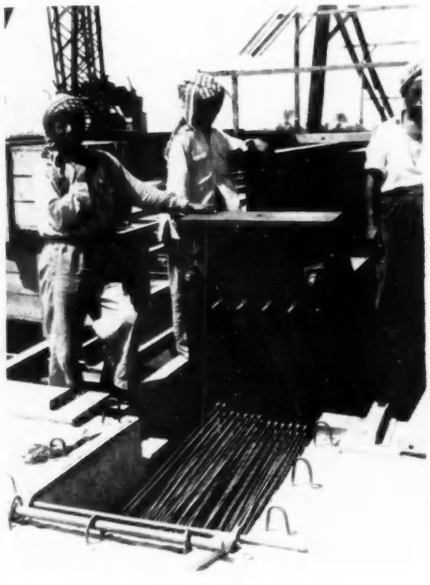


Fig. 6 (left) The 270 wires comprising each suspension cable are separately anchored into bloom plates at the ends of both girders. Gifford-Udall anchors were used to fix each wire.

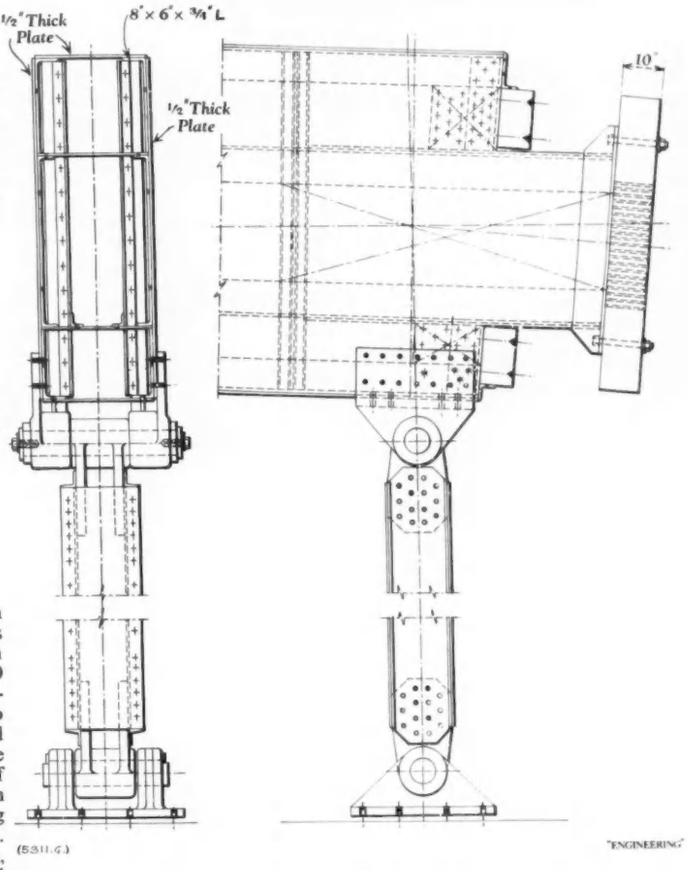


Fig. 7 (right) Cable anchorage and end trunnion support.

are therefore made up of a series of silty, sandy clays and beds of loose sand overlying strata of dense, as well as cemented sands. It is on these layers of dense sand, some 50 to 80 ft below river-bed level, that bridge caissons or piles have usually to be founded. Sulphates are present in varying proportions throughout the whole of the alluvial area of Iraq, the more soluble ones having been gradually brought up to the surface, where they settled out in the upper layers in high concentrations. For this reason it is nearly always advisable to take some precautions against sulphate attack, with *in situ* or even pre-cast concrete, either by using super-sulphate or sulphate-resisting cement or by applying surface protection to the concrete.

At Samawa crystalline gypsum occurs in dense sheets 4 to 6 in thick. These are embedded in very stiff sandy clays and present a barrier to penetration. For piling heavy steel tubes, of 18½ in bore with ¾ in thick walls, together with steel liners which had an annular clearance of ⅜ in, were driven through the softer surface strata to depths of around 25 ft. When final driving level was reached, the liner was withdrawn bringing the core with it. Only when the tube was founded on sand did core debris have to be washed out. Broad-flange joists, 12 by 12 in, were then inserted and driven down a further 25 to 30 ft, the tubes giving both stiffness and protection to the joists. Tests made on the joist piles alone, which had been driven to sets of about 120 blows an inch with a No. 10 McKiernan-Terry hammer, showed virtually no settlement under a load of 120 tons—twice the designed dead load of 60 tons, the maximum designed live load being an additional 23 tons. After driving the joists, the tubes were plugged with concrete using a bottom-opening skip. This same method of piling had been used for the road bridge designed by the same consultants at Hindiya and, on the experience gained there, the contractor on the Samawa bridge was able to apply some improvements in technique.

The piers were built inside cofferdams using *in situ* concrete, instead of the alternative method using pre-cast concrete shells for the piers.

The bridge was originally projected as a ground anchored structure but, due to the poor shear value of the soil in the upper strata at the abutments, the design was changed to a "self-anchored" or "self-supporting" structure; the anatomy of the bridge, and the principal forces, are shown in Fig. 2. There is a clear span between abutment bearings of about 527 ft. The supporting towers are positioned at the "quarter points" to give a clear navigational opening of about 245 ft, and the clear headroom under the bridge at the maximum recorded flood level is 16½ ft. The carriageway, suitable for two lanes of traffic, is 26 ft wide, and two footways, each 6 ft wide are cantilevered out from the main girders (Fig. 3). The roadway deck is formed of concrete jack arches having a minimum thickness (at the crown) of 4 in on which a 1½ in thick bituminous wearing surface has been laid. These jack arches span between rolled steel joists (7 by 4 in by 16 lb per ft) at one metre centres, with cross ties (4¾ by 1¾ in by 6½ lb per ft) also at one metre centres. The concrete arches are haunched down on to these ties to form a grid, one metre square, on the underside

Continuing **Construction**

of the bridge. The 7 by 4 in joists span longitudinally between 24¾ by 8 in plated beams at 3 metre centres which are framed into the main girders. The two pavements are of similar construction on RSJ's (8 by 5 in by 28 lb per ft) at 3 metre centres, cantilevered from the main girders.

The main girders are of box form 85 in deep by 29 in wide with ½ in web and flange plates connected by 8 by 6 by ¾ in corner angles. The maximum thrust taken by each girder is 547 tons; the maximum bending moment and shear are 3,400 tons-ft at mid-span and 130 tons over the piers respectively. The steel box-section towers are splayed to enable the main girders to pass inside the legs although the cables are supported over the vertical centre lines of the girders (Fig. 4). The towers are hinged at their bases over the piers so as to be free to take any inclination dictated by the cable (Fig. 5). At the south abutment the main girders are carried on fixed trunnion bearings; at the north abutment and at the lower cross girders of the towers they are carried on trunnion links (Fig. 7). The whole of the expansion is allowed for at the north abutment with a flat-plate expansion joint. All the steelwork is of high tensile steel to B.S. 548.

The suspension cables each contain 270 galvanised high tensile steel wires 0·276 in diameter, which were supplied by British Ropes Limited. The wires are gathered together into a hexagonal cross-section; the contractor adopted this form because it made the layering of wires in a uniform manner much simpler than is possible with a circular cross-section. The ends of each wire are held by Gifford-Udall anchors (supplied by Ductube Company Limited, London) at 1½ in centres into bloom plates, 72 in by 30 in by 10 in thick (Figs. 6 and 7). Provision was made for the insertion of two 200 ton jacks, one at the top and one at the bottom of each slab. In the original scheme of construction it was envisaged by the consultants that the main girders and decking would be progressively hung from the suspension cables and this jacking provision was made to make any necessary adjustments to the cable tensions that might be required. However, as it was possible to assemble the main bridge structure during the period when the flow of the Euphrates was low, the contractor preferred to adopt a method in which the main girders and deck steelwork were supported on trestles resting on the river bed. This work was so executed that, on removal of the trestles, no longitudinal adjustment on the cables proved to be necessary.

For protection, the completed cables were given a sealing coat of barium chromate paste and then tightly bound with 10 gauge soft iron wire, which was subsequently painted along with the remainder of the structure. From the last hanger the wires splay out to their anchorages and this portion was given protection by pouring hot bitumen around them so as to encase them completely. The cable hangers are formed from steel bars, 1⅛ in diameter, to EN16R specification, fixed to the girders by trunnions to obviate any tendency for the hangers to bend with relative movement between the girder and cable.

Provision for carrying service ducts and pipes is made under the footways and access manholes have been built into the pavement construction, but the cables for the sodium lighting used on the bridge have been run inside the handrails.

The main contractor for the construction of the bridge was Sir William Arrol and Company Limited, Glasgow; the consulting engineers Posford, Pavry and Partners of London.

BRITAIN'S FIRST MOTORWAY

Progress Report after Thirteen Weeks Work

Progress on the London-Birmingham motorway is ahead of schedule. So said Mr. Maurice Laing, managing director of John Laing and Son, the contractors, when the Minister of Transport and representatives of the Press were conducted over one section of the work recently. Just 13 weeks had then elapsed out of the contract period of 19 months—completion date is 31 October, 1959—and already half the excavation had been done and work started on 90 out of the 133 major bridges along the route. The motorway will comprise 53 miles of dual three-lane carriageways, each 36 ft wide. Access will be restricted to six places only, where there will be two-level junctions with slip roads. The contract is worth £15 million and roughly £5 million worth of equipment is in use, with a total of 80,000 h.p.; at peak the labour force will reach 3,500, including 600 key personnel, such as gangers and time clerks and above. Almost without exception this key staff was drawn from the contractor's own resources.

Earth-moving got underway quickly and in the first 13 weeks—which included both the Easter and Whitsun breaks—5 million cu. yd of spoil was removed, much of it to be used as fill along the route. In use are 72 scrapers (of both the crawler tractor and scraper and self-propelled rubber-tyred types) and 150 excavators; the rate of excavation has reached half a million cu. yards a week and the contractors have advanced their own target date for completing excavation from October to August. Unfortunately there has been heavy rain in June (1½ in over one weekend), and this new target may prove optimistic if the weather does not improve soon. Laying the marginal shoulders and lean mix (1 : 18) sub-grade began after the 10th week. Bridge construction, almost entirely in reinforced concrete, has been starting at eight a week and, during June, this figure has been stepped up to ten a week. Much of the drainage has also been laid. It was noticed that, in several structures where, a few years ago, it would have been thought essential to use reinforcement, the consultants have made use of plain concrete sections. An example of such work was to be found in the culverts being laid under the motorway.

The carriageways will be separated by a 15 ft central reserve on which trees and shrubs will be planted. On the outside of the carriageways there will be hard marginal shoulders. There will not, however, be the conventional kerbs. The side limits of the road will be marked by permanently white concrete strips set in the black bituminous surface; the concrete will retain its whiteness by the presence of an admixture of titanium oxide. These white strips are being put to good use during construction, for they are being laid on concrete haunchings which form shuttering for the lean mix base, the top of the strip also serving to indicate the depth of the work. The general plan is to complete the subgrade and all other work throughout the length of the road before laying the black top in a final completing effort.

At the lunch which the contractors gave on the occasion of the visit, Sir Owen Williams, the consulting engineer for the motorway, spoke on various aspects of the work. He made particular mention of the co-operation which had been received from all concerned, particularly in proving ownership. Altogether 115 miles of temporary fencing had had to be erected and 12,000 land plans prepared. Given the completion of one motorway, then the resistance and prejudice against them would disappear so that future work would be made easier by the reduction in the number of objections which would be laid against proposed roads. He also expressed the opinion that structures should be designed to "suit the age" and, to-day, that meant that the work should be "bold and massive" and characterised by its simplicity and repetition.

For the organisation of the contract a project headquarters has been established at Newport Pagnell, with the work divided into four sections corresponding to the four separate contracts in which it was let. To supervise the work the contractors and consultants are making extensive use of a Bristol Sycamore helicopter.

SIDE-TIPPING BUCKET FOR HIGH LOADERS

A new side-tipping bucket for high loaders, as shown in the illustration, was to be seen at the recent mechanical handling exhibition. The bucket has a capacity of 1 cu. yd and can be tipped either to the front or to the side of the loader. It is fully interchangeable with standard buckets made by Muir-Hill for their 2WL loader but an additional control valve and a three-bank selector (in place of the normal two-bank unit) has to be fitted. For normal forward

tipping a pin catch is fitted which prevents the side movement; removal of the pin allows the bucket to be used for side tipping. The loader, with the new bucket, was exhibited on the stand of E. Boydell and Co, Ltd, Manchester 16.

ADJUSTABLE FOUNDATIONS

Application of Flow in Plastics

The flow of plastics that will occur due to heating when an electric current is passed has found a new application in adjustable foundation pads suitable for correcting differential settlement. The pads comprise laminations of steel interleaved by plates of plastics (or metal of low melting point) and the means of passing a current through the steel.

This application, and the design of the pads, has been worked out by Mr. N. Dudley, formerly head of the winding section of the National Coal Board's reconstruction department, and Mr. A. Young, of the purchasing and stores department. Initially the pads were intended for use under the feet of towers which support colliery winding engines; such footings, particularly in mining areas, are liable to relative settlement and the pads have been found very suitable for applying corrections. The current is passed through one or more of the plates in as many pads as may be necessary and the rise in temperature causes the plastics to flow under the load on the footing.

Book Reviews

EAR DEFENCE

Handbook of Noise Control. Edited by CYRIL M. HARRIS. *McGraw-Hill Book Company Incorporated, 330 West 42nd Street, New York 36, N.Y., U.S.A.* (16·50 dol); and *McGraw-Hill Publishing Company Limited, 95 Farringdon Street, London, E.C.4.* (124*s.*)

As the pace of life has increased over the years and more aids to living have been introduced, there has been an almost continuous increase in noise as part of the price to be paid for the faster, easier life. At first, this increase in noise was accepted as a clear demonstration of man's growing command over the forces of nature, an impressive example being the full-throated roar of a steam locomotive. Later, however, a new generation began to take the advantages for granted and became critical of the noise. Reactions ranged from mild annoyance of individuals with some noises to concerted action by whole communities against other noises. In addition, there is the possibility in extreme cases of permanent impairment of hearing due to prolonged exposure to intense noise. The need for a book dealing comprehensively with noise control is therefore obvious.

The editor of the present book, Dr. Cyril Harris, who is Associate Professor of Electrical Engineering at Columbia University, is well known throughout the world for his contributions to his subject and his work on international committees dealing with acoustical standards. From his world-wide circle of friends and colleagues he has enlisted 46 specialists in the various branches of noise control to contribute chapters on their respective fields. Professor Harris himself, in an introductory chapter, outlines the general principles of noise control, at the source, in transmission, and at the listener; and defines the specialised acoustical terms which are used in the book. Some of these terms, such as the phon and sone, have only recently been accepted internationally.

In the succeeding 39 chapters, the various specialists write authoritatively on the latest methods of reducing noise. Since vibration is often the cause of noise, five chapters are devoted to its control and its effects on the human body. Problems associated with noise in buildings, including the use of acoustical materials, occupy three chapters and this is probably sufficient in a book not specially concerned with architectural acoustics. Control of the noise of machines such as gears, fans, air conditioners, transformers, motors, automobiles and aircraft, is dealt with in twelve chapters and constitutes an impressive attack on noise at its source.

Problems of town planning to avoid noise nuisance and methods of assessing community reaction to noise are also discussed, together with the legal aspects of nuisance and liability for loss of hearing. The book concludes with a chapter on the noise control requirements in building codes in those countries, outside the United States, where they have been introduced. With so many authors, the problem of maintaining uniformity of style, terminology and units must have been herculean but the editor has, in the main, succeeded. All pages, figures and tables bear the appropriate chapter number so the finding of a particular item from the table of contents is facilitated. Each chapter has ample references and there is a comprehensive index.

NEW BOOKS

An Introduction to Press Tool Design. By J. PALMER. *The Association of Engineering and Shipbuilding Draughtsmen, Onslow Hall, Little Green, Richmond, Surrey.* (3*s.* non-members, 1*s.* 6*d.* members.)

This 68-page manual for tool designers covers presses and attachments, punch and die details, cutting dies, bending and forming, cupping, drawing and redrawing, and other operations. It is profusely illustrated with clear line drawings, and includes tables of material strengths and weights, formulae for blank diameter and standard wire gauges.

Aerodynamics. A series of papers revised and reprinted from "Research," Vol. 10, 1957. *Butterworths Scientific Publications, 4 and 5 Bell Yard, London, W.C.2.* (7*s.* 6*d.*)

Six articles are included in this 48 page volume: "Aerodynamics: Theory and Practice," by T. Nouweiler—a general introduction to concepts of lift and drag, the theory of air flow, variation of pressure and viscosity effect; "Wings and Bodies in Low Speed Flow," by J. L. Stollery—a brief exposition of the main concepts of the regime of incompressible flow; "Aircraft Performance, Stability and Control," by A. Babister—from a physical, non-mathematical, standpoint; "High Speed Flight," by J. Black—outlining compressibility effects, the behaviour of aerofoils at high Mach number, design features of transonic and supersonic aircraft, aerodynamic heating, and propulsion considerations; "The Aerodynamic Laboratory," by J. Black—considerations of dynamic similarity, wind tunnel design and types of wind tunnels, balances, pressure and velocity measurements, optical techniques and flow visualisation; "Current Aerodynamic Problems," by W. J. Rainbird—the supersonic airliner, missile aerodynamics, and the heating problem.

TRADE PUBLICATIONS

Copies of any of the following trade publications are obtainable from the addresses given, though distribution is sometimes restricted.

Bituminous-Epoxy Coating. WAILES DOVE BITUMASTIC LTD., Hebburn, Co. Durham. Newly-developed protective coating for metal and concrete surfaces intended to combine the waterproofing properties of coal-tar pitch with the resistance, to chemical attack and corrosion, of epoxy resins. The coating, Epimastic, it is claimed, is also resistant to abrasion and wear. Illustrated leaflet.

Extrusion Press Components. HADFIELDS LTD., East Hecla Works, Sheffield, 9. Steel castings and forgings such as containers, cylinders, liners, rams dies and other extrusion press components, of all sizes. Illustrated brochure, with tabulated detail of steel analyses suitable for components to be used under various conditions.

Connector for Soil Pipe. TURNERS ASBESTOS CEMENT CO. LTD., Trafford Park, Manchester, 17. "Everite" connector for providing gas-tight junctions at the approved angle of 92½° between 1½ in or 1½ in waste pipes and the main vertical asbestos cement soil pipe having a nominal diameter of 3½ in and 4 in. Available as a single or double unit. Illustrated leaflet.

Electric Furnaces. ROYCE ELECTRIC FURNACES LTD., Sir Richard's Bridge, Walton-on-Thames, Surrey. Electric furnaces of many different types, including bell, pit, box, tube, drum and conveyor. Special atmosphere and vacuum furnaces are listed, together with special purpose equipment. Illustrated brochure.

Insert for Pipe Welding. ROCKWELD LTD., Commerce Way, Croydon, Surrey. The E.B. weld insert is used for pipe joints where a root run weld must be of the highest quality. It comprises a wire of special section fitted between the prepared ends of the pipes to be joined and subsequently fused to provide a high-quality weld and a smooth contour both internally and externally. The wire insert is available in mild steel, low-alloy steel and stainless steel. Explanatory leaflet.

On the Shelf

By Frank H. Smith

I derived a great deal of pleasure from reading an article in the *Unesco Bulletin for Libraries* of May-June. It was a description of the Valentin Haüy Association's Braille Library in Paris and it starts with a little historical note on the origins of Braille. I was amazed to learn that Louis Braille was only 15 when he produced his wonderful alphabet and it was complete in all respects in its original form. I wonder if compilers of lists of geniuses include him?

A firm calling itself "General Astronautics" (P.O. Box 2151 Grand Central Station, New York, 17) have sent me their space-flight book list. Tnis seems to be quite a comprehensive list, not, apparently, science fiction stuff. One assumes that General Astronautics is in the same regiment as Corporal. Corporal whom? Just Corporal.

Heywood and Company (I've mentioned them before but they're at Drury House, Russell Street, W.C.2) announce *Communications and Electronics Buyers' Guide, Who's Who and Reference Book.* It contains 32,400 references—they say—and at 5 guineas it works out (I think) at about 308 references for a bob. Which is not bad going. It would seem that Heywood will supply the book post free on receipt of your order.

Soviet News (never a dull moment) of 5 June has a little piece on a universal information machine. A group of Soviet scientists under Dr. Lev Gutenmacher (honest it is) are developing, in the Electric Modelling Laboratory of the Academy of Sciences, the "Automatic Library of Scientific Literature." So far they have got up to eight questions and answers.

The list of 2,500 scientific papers to be presented before the 1958 International Conference on the Peaceful Uses of Atomic Energy, 1-13 September, is being made available by the Document Service of the Chronicle of United Nations Activities. If you are determined to get at these, all 2,500 of them, you can get a free list from Atomic Energy Document Service, the Chronicle of United Nations Activities, 234 West 26 Street, New York 1.

The Water Pollution Research Laboratory (one of the D.S.I.R. bodies) of Elder Way, Stevenage, Herts., has started "Notes on Water Pollution," No. 1, dated June, 1958. These are chiefly intended for industrial readers and the first number is devoted to "Effect of Organic Discharges on the Level of Oxygen in a Stream." I should mention that the extension of research into pollution has been made possible by a "considerable financial contribution from the Federation of British Industries."

The Computer Department of Ferranti (21 Portland Place, W.1) have performed a useful service by producing a second issue of "List of Existing Programmes" of Pegasus. I rather like their invitation to all users to advise the titles of programmes "subject to considerations of military or commercial confidentiality."

Interavia, the Geneva-published international aeronautical journal is celebrating its silver jubilee and the June number is devoted to 25 years of aviation. They are staging an essay competition (1,500 dol first prize, 1,000 dol second), the subjects being "Air Travel for All"—how can air travel be made popular and widely available—and "Guided Missiles or Piloted Aircraft." Closing date is the last day of the year which is, of course, 31 December. The editors, who have never been lacking in a sense of humour, take the mickey out of themselves with an article "Editors on Thin Ice," in which they describe occasions when they have been taken for a ride.

The British Productivity Council offers ten guineas for the design of a distinctive emblem for the B P C It should be adaptable to a wide variety of uses, e.g., correspondence, exhibition stands, publications and films. Mark your entry "B P C Emblem Competition," to 21 Tothill Street, S.W.1, by 15 July. I'm bursting with ideas but I cannot draw.

Production

IMPERIAL CHEMICAL INDUSTRIES

The impetus provided by the demands of the aircraft industries and the applications of nuclear energy have led to some outstanding metallurgical developments in the last decade. The story of titanium—which was first discovered in 1791 by an English clergyman, the Rev. William Gregor but which, on account of the difficulties of extraction from its ores, remained a chemical curiosity for more than one hundred years—is one of the most remarkable. For since 1934, the annual world production of the metal has risen from practically nothing to over 25,000 tons. Most of the world's titanium output comes from the United States where from 1934 onwards the Kroll process (in which the titanium ore is converted to titanium tetrachloride and then reduced to the metal by magnesium) has been operated to produce ductile titanium. The Kroll process has also been employed in Japan and Britain—Imperial Chemical Industries Limited being the major industrial concern in this country extracting the raw metal on a commercial scale.

Fig. 1 General view of sheet finishing bay.

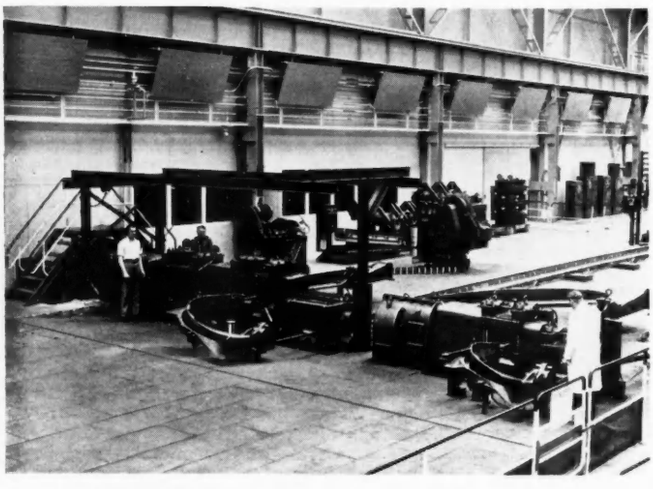


Fig. 2 Morgardshammar 5-stand guide mill for finishing rod down to 0·25 in dia.

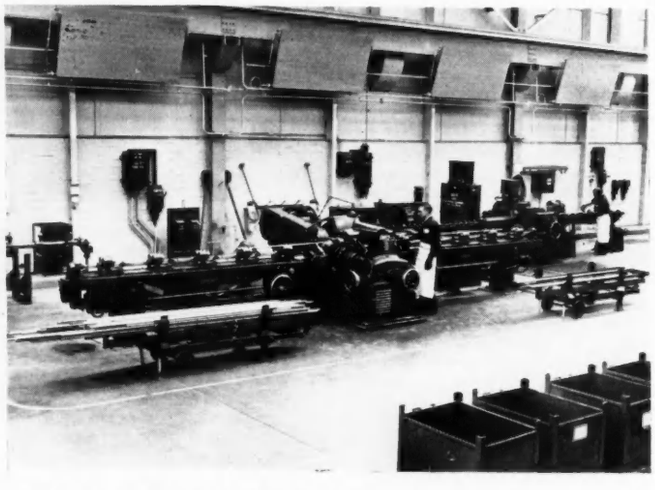


Fig. 3 Lidköping centreless grinding machine for bars up to 4 in dia.

Although the General Chemicals Division of I.C.I. Limited built a Kroll plant in 1949, titanium production is now based on a better and cheaper process of extracting titanium resulting from the research and development work undertaken by the company in which sodium, instead of magnesium as in the Kroll process, is used to reduce the titanium tetrachloride. Easier leaching out and better control of the purity of sodium as compared with magnesium, resulting in a purer product, are the advantages of the new process as compared with the Kroll process. A large-scale plant with an output of about 1,800 tons of titanium per annum was therefore built by I.C.I. Limited at Wilton, Yorkshire and has been in continuous production since the first half of 1955.

The second stage leading to the production of forged products is the 2,000 ton per annum titanium melting plant at Wilton. The high melting point of the metal—about 1,700°C, or 200°C higher than that of steel—and its reactivity with oxygen, nitrogen, carbon, and other materials including most refractories, made it necessary to develop special melting and ingot casting techniques. The method used is electric-arc melting in water-cooled copper crucibles which are evacuated or filled with argon. Consumable titanium electrodes are used; these are made by compacting titanium powder (combined, if required, with other powdered metals) to form a block with the required electrical characteristics. As developments have proceeded, the melting furnaces at Wilton have been changed, the most recent installation (March, 1958), being three vacuum-melting furnaces supplied by W. C. Heraeus, G.m.b.H. (Western Germany) and operating on the same basic principles as the smaller furnaces they are replacing but embodying many new features. Special provision is made for the safe operation of these furnaces. All operations are controlled remotely, the furnaces themselves being enclosed in massive reinforced-concrete cubicles to ensure complete protection. In the control room, optical systems give the operator a clear view of the furnace interior throughout the melting process. Each of these furnaces can produce an ingot weighing 4,200 lb (equivalent to an 8,000 lb steel ingot), the three furnaces together having an annual output of over 2,000 tons, as compared with the 18 smaller furnaces needed in 1955, for an output of 1,500 tons a year. The larger size ingot from the new furnaces—twice the size of any produced previously in this country—are more economical to roll since there is less loss in removing ingot surface imperfections, and long-length coiled strip can be produced.

TABLE I.—*Mechanical properties of I.C.I. commercially pure titanium and titanium alloys in the annealed condition and at room temperature.*

Chemical Composition	Commercially pure			2 per cent Al–2 per cent Mn alloy	4 per cent Al–4 per cent Mn alloy	5 per cent Al–2½ per cent Sn alloy	6 per cent Al–4 per cent V alloy
	Titanium 120	Titanium 430	Titanium 160	Titanium 314C	Titanium 314A	Titanium 317	Titanium 318A
Mechanical Properties							
Ultimate tensile strength tons/in²	20—30	28—40	40—52	40—52	6 min.	50 min.	62 min.
0·1 per cent proof stress tons/in²	13 min.	18 min.	30 min.	30 min.	57 min.	45 min.	57 min.
Elongation per cent on $4\sqrt{A}$	20 min.	18 min.	15 min.	15 min.	15 min.	10 min.	10 min.
Young's modulus 10^6 lb/in²	15—17	15—17	15—18	15—18	16—19	15—18	15—17
Fatigue limit (approx.) per cent of U.T.S	50	50	50	60—65	60—65	60—65	60—65
Bend radius (16 s.w.g. or thinner sheet)	2T	2T	3T	—	—	4T	5T

TABLE 2.—*Comparative Physical Properties*

—	Titanium	Aluminium	Copper	Iron	Magnesium
Melting point °C	1,660 ± 10	660	1084	1535	650
Thermal conductivity cal/cm cm² °C at 20°C	0·0407	0·57	0·92	0·17	0·35
Electrical resistivity microhm-cm at 20°C	55·4	2·68	1·72	10·0	4·4
Coeff. of therm. exp. 10^{-6}/°C	8·9	24·0	16·4	11·9	25·7
Elastic modulus 10^6lb/in²	15	10	17·5	29	6·5
Density g/cc	4·51	2·70	8·94	7·86	1·74
Normal electrode potential volts	−1·75	−1·67	+9·52	−8·86	−2·38

TITANIUM PLANT IN WALES

It was these developments in the extraction and melting of titanium and the steadily increasing demand from the aircraft industry for components fabricated in titanium which lead I.C.I. Limited in 1955 to plan and construct an entirely new plant solely for the production of wrought titanium.

A site adjacent to the I.C.I. aluminium plant at Waunarlwydd, near Swansea, was selected for this plant for the production of rod and sheet. It consists of two separate buildings, of similar design. One to house the heavier rolling equipment for the rod and sheet and the other, only a short distance away, the lighter finishing equipment. The latter building has a completely enclosed lean-to bay containing the pickling equipment.

Design and Construction of Plant

The I.C.I. Metals Division, engineering department, were mostly responsible for the design of the buildings and the firm of contractors, H. K. Ferguson (Great Britain) Limited, supervised and progressed the construction work on site. Work began in February, 1956, with the laying of the foundations for the heavy plant and the first production rolling was started in March, 1957, only 13 months later—a remarkable achievement. The new plant has cost £3 million and employs about 200 persons.

The two buildings, each having two bays, are of portal frame design, the main units, rafters, Y-pieces and columns being welded steelwork with all welds ultrasonically tested *in situ*. The main foundations provided for a raised factory floor some 15 ft above possible flood level of the surrounding ground. Steelwork was erected, starting from the office block, using a mobile crane and Norstel scaffolding bridges were erected in each bay to allow overhead work to proceed while rolling plant and other equipment was being installed on the floor. The building is clad with I.C.I. " Kynalok " aluminium, insulated and steam heated by radiant panels. There are Perspex roof lights and an efficient system of artificial lighting. All the bays have overhead cranes, the crane tracks being thermit-welded into single lengths and mounted on rubber pads with spring clips to allow for expansion; the crane rails are also fitted with vertical steel wearing strips to take the side thrust from separate thrust rollers on the cranes instead of using flanged wheels.

Rolled Rod

Although experience gained in the working of aluminium, copper and steel is useful when considering the production of titanium rod or sheet, the production of the latter has proved to be a far more difficult process, and the particular characteristics of this new commercial metal had to be taken into account when selecting equipment and determining the processes to be used in production. Compared with more common ferrous and non-ferrous metal practice these may be summarised briefly, as follows: heavier rolling loads for a given reduction in section partly because of the high coefficient of friction between titanium and steel; its surface is readily contaminated by gaseous absorption at elevated temperatures, and above 800° C it dissolves its own oxide, resulting in surface hardening which must be avoided by limiting the temperature, duration and method of heating, electric furnaces being used; it has a low heat capacity and tends to lose heat rapidly, this with the restrictions on reheating shortens the working time; descaling, as with most corrosion resisting materials, is difficult; the high cost of material and the need for the greatest production yield has to be constantly borne in mind, so that at all stages dressing is done to remove any surface blemishes and there must be a constant striving for dimensional accuracy.

In the rod mill the process is essentially one of preheating and hot rolling rod in closed passes to finished size. In general, a sequence of square passes, followed by alternate squares and ovals, is used; the final round section is formed from an oval of suitable size. The starting stock is 5 in square or 6 in diameter billet up to 150 lb in weight, forged from ingot in the melting plant at Witton. After preheating in one of two Birlec electric furnaces equipped with walking beam conveyors, the billets pass to a Robertson 2-stand 3-high roughing mill where they are reduced to 2½ in square sections and allowed to cool. The next stage is to cut the material to convenient length using an abrasive cutting machine and reheat for further intermediate rolling in cogging mills to a suitable size for the finishing mill.

A Swedish Morgardshammer 5-stand guide mill has been installed for finishing rod in the range 2 in to 0·25 in diameter. This mill is one of the outstanding features of the plant. It is in two parts, one d.c. motor of 900 h.p. driving three stands and a second motor driving the two smallest stands. The deflection of the short rolls during rolling is extremely small and rod of consistent and accurate dimensions can be produced, enabling them to be fed direct to the centreless grinding machines with a minimum grinding allowance. It was initially intended to allow for 30 thou. in oversize, but closer tolerances than this are being achieved. The stands are detachable for roll changing and pre-setting in a separate shop, the short rolls in roller-bearing chocks being held together by very rigid screws. Roller guides are fitted to all stands and this is advantageous because of the tendency for titanium to gall in frictional contact with steel. Repeaters are provided for passing the rod automatically between the stands. The exit speed from the fifth stand of the rolling mill may be up to a maximum of 1,500 ft per minute.

From the Morgardshammer mill, roller conveyors convey the rod to cut-off shears and two Bronx reeling machines for 25 ft lengths. There is also a Loewy coiler for smaller diameter stock.

The material is transferred to the second building or rod finishing bay where it is cut to length, centreless ground or turned, or lathe

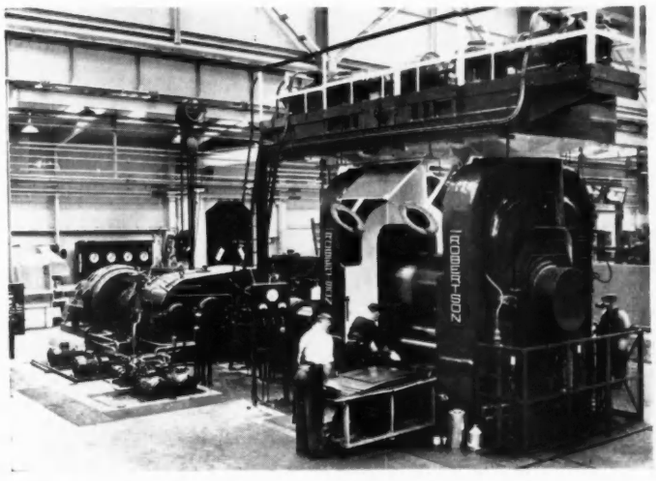


Fig. 4 Robertson 4-high mill for cold rolling commercially pure sheet.

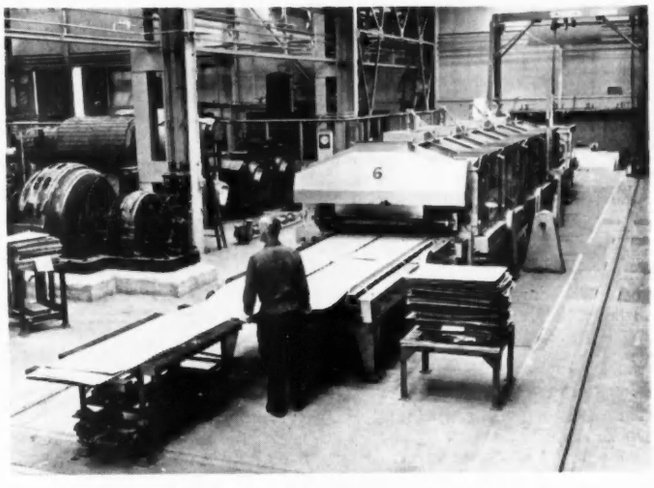


Fig. 5 GWB continuous roller hearth annealing furnace.

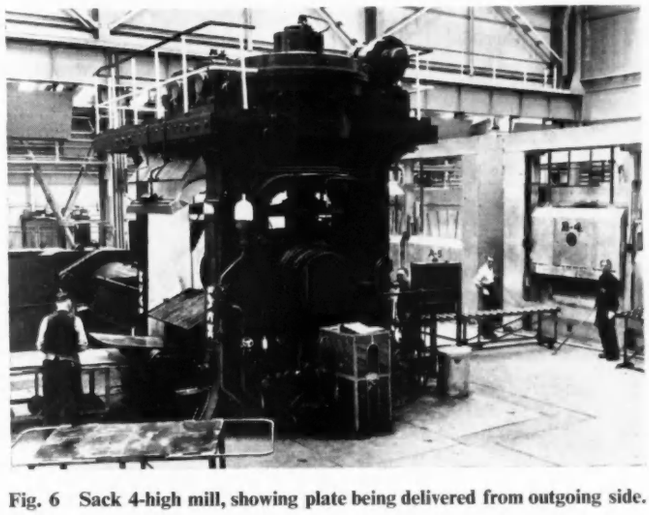


Fig. 6 Sack 4-high mill, showing plate being delivered from outgoing side.

Design

CONTOUR SQUEEZE MOULDING

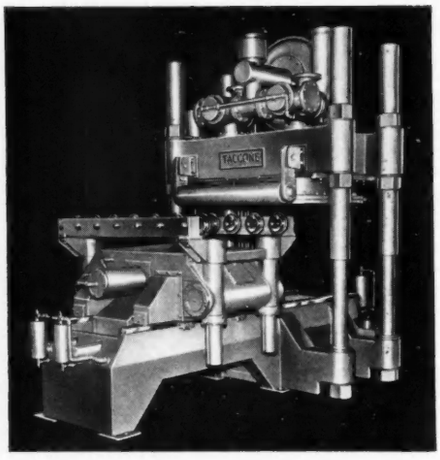
One of the most important factors in the production of accurate and consistent sand moulds is uniformity of moulding pressure on all parts of the sand. Given a very simple, shallow pattern, with little variation in height over its whole area, the requirement of uniform pressure is fairly easily met by any moulding process, but when the pattern is irregular in shape and thickness the problem becomes much greater.

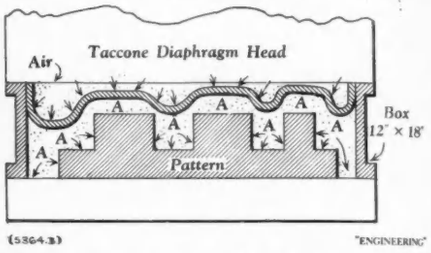
The Taccone " Diaform " moulding machine, developed by Mr. R. W. Taccone in the United States, solves the problem of providing uniform moulding pressure regardless of pattern shape in a simple manner, and at the same time has other advantages. Taccone machines have been widely adopted in America and certain European countires, and are now available in Great Britain, Baker Perkins Limited, Westwood Works, Peterborough, having made arrangements to market the machines here, under licence from the Taccone Pneumatic Foundry Equipment Corporation, North East, Pennsylvania, U.S.A.

In basic principle the Taccone machine is simple. A moulding box, with its pattern or pattern plate in position, is filled with sand by gravity, and placed under the compression head of the moulding machine. This consists of an air chamber, closed on the lower side by a flexible diaphragm. Air is admitted to the chamber through directional valves, and the diaphragm is pressed down on to the surface of the sand in the box. Pressure is thus distributed uniformly over the whole area of the box, and the sand below the diaphragm is compressed to follow the countour of the pattern. To allow the diaphragm to have a proper searching effect over all parts of the mould, it is deliverately made slack, so that it would, in fact, lie in folds on the top of a flat-backed mould. This surplus of material in the diaphragm enables it to reach down into deep pockets anywhere over the mould area.

A study of the process shows that the thin parts of the sand are compressed first until they reach the degree of compaction necessary to resist the applied pressure, when compression at those points ceases; it continues, however, on the remaining thicker areas of sand until those, too, are compacted to the same degree. Air trapped in the sand as the diaphragm descends escapes through holes in the pattern plate.

The Taccone machine requires no skill to operate it and it can, in fact, be made to work automatically. Speed of moulding is largely dependent on the speed at which the moulding boxes can be handled to and from the machine, as the actual compression takes place in about





(Above) The principle of the Taccone machine shown diagrammatically. The pressure surface of the diaphragm is some 40 per cent greater than the box area.

(Left) Uniform moulding pressure, regardless of pattern shape, is a feature of the Taccone machine, which is simple to operate and can be made to work automatically.

Continuing ICI Titanium Plant

turned. There are four grinding machines in this bay including a Lidköping machine with powered tables capable of grinding bar up to 4 in diameter. Heat-treatment facilities are also provided for alloy rod. The bars are etched in a hydrofluoric/nitric acid bath for final inspection before entering the combined sheet and rod warehouse to await dispatch.

Sheet

The rolling process is dependent on the material, a distinction being made between the commercial grades of titanium (120, 130 and 160), which may be finished by cold rolling, and the more difficult titanium alloys (317 and 318A) which require to be hot-rolled to finished gauge.

The starting stock in both cases is hot-rolled strip nominally 24 in wide and 0·2 in thick, produced from 800 lb forged and machined slabs at Wilton, Birmingham. At Waunarlwydd, the strips are cut into sheet blanks, descaled and dressed for further rolling to the required gauge by the single sheet method.

For commercially pure sheet the process is essentially a series of cold rolling and annealing operations with dressing, descaling and pickling as required, at various stages of reduction. Initial breakdown from 0·2 in to 0·090 in is done on a Lauth 3-high mill in the heavy bay. Final cold reduction down to 0·008 in is by means of a Robertson 4-high mill having rolls 68 in wide and either 16½ or 14½ in dia. A load meter is is fitted to indicate the preset and rolling pressures. This mill has been modified to enable it to work at loads up to 2,000 tons. Because of these high loads there is heavy roll wear and frequent regrinding is necessary. The difficulty in cold rolling titanium is further emphasised by the full 3-shift output of this mill a year, of only a few hundred tons of metal about one tenth the output obtained with copper or brass.

Intermediate and final annealing of the sheet is done in a GWB electric furnace equipped with a disc roller hearth for continuous operation at temperatures up to 1,000°C. This method ensures uniform annealing so that the sheets remain flat and have an even oxide scale which is easier to remove.

Descaling of the sheet after annealing is done by acid pickling in a series of tanks with hydrofluoric, nitric and hydrochloric acid mixture; the process also includes a chemical scale modification treatment which facilitates removal of the scale. Special precautions are taken in the descaling plant, which is separately enclosed from the rest of the finishing plant, to protect the operators from any hazards arising from the use of these dangerous chemicals.

Alloy sheet, the alloy in greatest production being titanium 317, is hot rolled making small reductions in thickness at each pass, and preheating for each stage. A Sack 4-high mill with 60 in wide rolls is used to obtain the maximum reduction between each re-heat. High loads up to 40 tons per inch length of roll may be applied, calibrated load meters being used to record the rolling pressures. Two electric furnaces, each with two heating chambers, are used for preheating the sheet. Hot rolling is interrupted at various stages for mechanical descaling and dressing—care being taken in the extraction of the titanium dust to avoid dangers of fire or explosion.

In the sheet finishing bay for both hot and cold rolled sheet there is equipment for sheet dressing by hand or machine scraping, roller levelling and stretching machines, guillotine shears and final inspection benches.

Products

The production capacity of the new rod plant is of the order of 1,500 tons per annum of rolled bar and rod, lathe turned, centreless turned or centreless ground in the range 5 in dia. to 0·25 in dia. in the complete range of the company's titanium materials. Rod is produced to the close tolerance of 0 to +0·003 in and to a standard range of sizes based on the internationally adopted system of " Preferred Numbers " (as recommended by B.S. 1638 : 1950 and B.S. 2045 : 1953) in which each diameter of rolled rod is both a standard metric and a standard decimal inch size in the same series of numbers, with a geometrical progression of size over the range. The sheet production capacity is of the order of 300 tons per annum of commercially pure titanium, or 150 tons of commercially pure titanium and 50 tons of alloy sheet per annum. Cold rolled sheet is available in 2 ft, 3 ft and possibly 4 ft widths and in thicknesses down to 0·008 in for 2 ft widths. Hot rolled alloy sheet may be supplied in widths up to 3 ft and thicknesses down to 0·024 in.

Applications

The main market for titanium has been the aircraft industry where by replacing steel it gives a significant reduction in weight for components fabricated from sheets such as fire walls, bulkheads, engine cowlings, exhaust shrouds and hot air ducts; while most of the rod has been used for the production of compressor blades. Fortunately, in view of the recent recession in the aircraft industry and the fall-off in orders for this particular application, other useful properties of titanium such as its exceptional resistance to corrosion in media which rapidly attack stainless steel suggest that there may be a promising market as a material for chemical engineering plant and other special equipment as used for bleaching and paper pulp manufacture. Other applications are as an electrode material and uses involving cathodic protection. I.C.I. Limited have already spent £2 million on research and development in connection with titanium and its alloys, and are still devoting £½ million per annum to this effort—a good indication of the confidence placed in the future for this new metal.

With the steady increase in demand, price too has steadily fallen. In 1953, the price of raw titanium was 50*s.* per lb and by this year had fallen to 14*s.* 6*d.* Sheet in 1953 was, on an average, £15 a lb and has now fallen to £6 a lb. Further reductions on these prices ranging from 5 to 20 per cent were announced on 4 June.

Continuing **Design**

1½ to 2 seconds. The pattern is not subject to shock, and abrasion of the pattern surface is reduced to a minimum, consequently, wood or plastic patterns can be used for long runs. Special foundations are unnecessary—the machine can stand on simple foundations or be suspended on girders over a spill conveyor leading to the foundry sand preparation plant. As an example of the close control of dimensional accuracy, a total weight variation of 4 oz has been achieved in regular production of iron castings weighing 40 lb. Finally, the machine is almost silent in operation, and maintenance is negligible. Diaphragms have been found by experience to produce 60,000 to 80,000 moulds before they need replacing. When this does become necessary it can be done quickly and easily, and the cost of the diaphragm is low.

NO SIZE LIMITATION

The design of the machine imposes no limitations on its size. At present a range of eleven sizes, to suit boxes from 12 in by 18 in to 36 in by 96 in is regularly available, but other sizes can be made without difficulty; in fact it can be said that if the foundry can handle the boxes a Taccone machine can be provided to make the moulds.

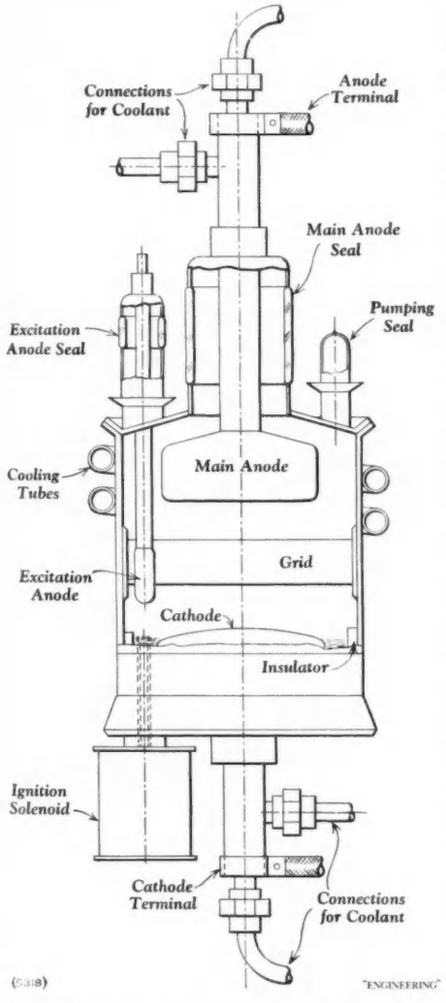
It is obvious that various adaptations based on the diaphragm head are possible, to suit individual requirements. In a typical arrangement the machine is equipped for installation in a roller conveyor line. An empty moulding box is pushed by a compressed-air cylinder from the conveyor to the moulding machine roll-on-rails, which then lower it on to a wheeled traverse car carrying the pattern plate. The car then moves inwards to bring the box under the squeeze head, and as it does so it passes beneath a metering box and chute which feed a predetermined quantity of sand into the box. Even distribution of the sand is ensured by the shape of the chute, coupled with the movement of the box on the traverse car.

As soon as the box, charged with sand, is under the squeeze head, air at 80 to 100 lb/sq. in is admitted behind the diaphragm, which then forms the mould. Different degrees of mould hardness can be produced by varying the air pressure. When the pressure is released the diaphragm is drawn clear of the mould by suction from a fan mounted on the head of the machine and the traverse car can thus move freely out to its loading position. Here, the roll-on rails rise to lift the completed cope or drag, as the case may be, off the pattern plate, so stripping it automatically, and raise it to roller conveyor level, so that it can be pushed off to move to the next station. An empty box then takes the place of the filled one, and the cycle re-commences. The time taken to produce a cope or drag with such an arrangement of machine and conveyor will vary with several factors; a typical cycle time would be about 20 seconds.

Two Taccone machines can be used, one for the cope and the other for the drag, in a roller conveyor moulding, coring, closing, pouring and shake-out circuit of the normal loop type. Alternatively, both halves of the mould can be produced on the same machine simultaneously, or a turntable pattern carrier, power indexed, can be used for the production of moulds from several different patterns on the same machine, in any required sequence.

SINGLE-ANODE RECTIFIER TO WITHSTAND VIBRATION

Electrification of certain British Railways main and suburban lines on the 25 kV, 50 c/s, single-phase system has brought the need for rectifiers of much smaller size for a given output than conventional mercury-arc types, and suitable for installation in vehicles subject to vibration, impact shocks, and other random movements. To meet these conditions, General Electric Company Limited has developed a new unit, the " Com-Pak " mercury-arc rectifier. Rectifiers of this type are to be installed in the locomotives and multiple-unit equipments which the company are supplying for a.c. electrification on British Railways. This type of rectifier also has advantages for certain conditions of industrial service, particularly where space is limited.



The igniter is of the " squirt " type, a plunger being pulled down by an external solenoid.

The " Com-Pak " rectifier is a single-anode cylinder with liquid cooling. It is being made in two sizes, the C7-Mk1, rated to give a continuous output of 120 A at up to 1,250 V, and the C9-Mk1 unit, rated at double this capacity. Overload capacity is 125 per cent of rated current for 2 hours, in accordance with B.S.1698 class II.

Cathode spot stability combined with efficient cooling has made it possible to achieve the high outputs required within the limited dimensions of these rectifiers. Furthermore, the company claim that in the " Com-Pak " rectifier the arc path is shorter, the voltage drop lower, and consequently the efficiency higher than in conventional types of mercury-arc rectifier. The anchoring of the cathode spot has also facilitated the incorporation of additional devices to restrict swilling of the mercury caused by vibration and shock, while enabling certain other forms of baffle to be dispensed with so that a smaller separation than usual between the anode and cathode becomes practicable. The lower arc drop also reduces cooling requirements.

The igniter is of the " squirt " type. A plunger is pulled down by energising a solenoid external to the rectifier, which forces a jet of mercury from a small nozzle against the excitation anode and completes the circuit to establish a direct current arc between the excitation anode and the cathode. This continuous excitation current is used to actuate a contactor which breaks the ignition solenoid circuit and allows the plunger to rise again to the top of the ignition tube. In the event of failure of the excitation current, the contactor re-closes and re-energises the ignition solenoid.

Excitation current varies between 3 and 6 A, depending on the supply voltage. The excitation circuit for each rectifier cylinder is fed from a separate source and is self-contained.

In electric motor coaches and locomotives, the rectifiers will be connected to give full-wave rectification. Eight cylinders, supplying the four 200 h.p. motors of a motor coach, together with the cooling apparatus and water pump, will occupy a cubicle measuring approximately 6 ft 4 in long, 2 ft 9 in high and 2 ft 6 in deep. Ignition circuit equipment will be installed separately in another case. An installation for a 3,300 h.p. locomotive might be divided between two cases, each about 6 ft long, 4 ft 6 in high and 2 ft 6 in deep, containing all the apparatus except the coolant pump, which would be mounted separately.

SHOCK TESTED

Tests of the rectifiers have been carried out in close collaboration with British Railways. For this purpose, two bogie parcel vans were made available. One housed a 130 kW diesel-alternator set which provided the source of power, and the other contained the rectifier equipment, transformer and loading resistance. The rectifier equipment included four units (one acting as a spare) assembled in a framework comparable in size with that which would be used for under-carriage mounting on multiple-unit rolling stock. The transformer permitted two conditions of direct current loading, namely 130 A at 1,000 V or 260 A at 500 V, giving a current loading on each rectifier of 43 and 68 A respectively.

Tests included repeated shunting at walking pace against fixed buffers, giving rise to particularly violent shocks on the rectifiers. This was followed by runs at speeds up to 45 m.p.h. which included emergency stops and accelerations. The vans formed part of a close-coupled passenger coach train, and trial runs were made with the test vans at the front of the train and repeated with the vans at the rear. Similar tests were made with the vans attached to loose-coupled freight trains, when the shocks experienced were more severe than those likely to occur in normal service. Finally, the test vans were coupled close to the locomotive of a high-speed passenger train, when speeds up to 90 m.p.h. were recorded.

Throughout these tests, the performance of the equipment was satisfactory, only minor modifications to the mounting of the rectifiers being needed to give improved flexibility.

During the test a Hallade recorder was used by officials of British Railways to provide a continuous recording of vertical, horizontal and canting movements as well as speed, acceleration and deceleration. From this information a rocking platform has been constructed for use at the works. With the equipment, service conditions are closely similated and rectifiers have now been tested under continuous full-load and cyclic loading conditions such as would occur in normal traction service.

Engineering at Home

HEATING AND LIGHTING

Domestic equipment makes up a large part of the exhibition that accompanies the British Electrical Power Convention. Some of the items shown this year are mentioned below. A.E.I. Lamp and Lighting Company Limited, Aldwych, London, W.C.2, showed a surface diffuser fitting suitable for interiors where low surface brightness is important. The fitting consists of a bonderised sheet steel box and either a polystyrene louvre or a Perspex diffusing panel. Submersible and dust-proof fluorescent fittings were exhibited also. The submersible fitting, for use with a single 80 watt 5 ft lamp, is made of gunmetal and Perspex, and withstands high pressure and salt water corrosion.

New radiant fires shown by E. K. Cole Limited, Southend-on-Sea, Essex, included the Victor range, available in three loadings. Features include pencil slim high-temperature elements, element supports of monel metal, and reflectors giving large heating areas. A panel fire has been designed for easy installation by mounting on a wall without recessing. It projects 3 in. The " Firestreak " wall fire, as it is called, incorporates an adjustable reflector, enabling the heat from the silica-glass sheathed spiral element to be directed as required. An electric blanket shown by the same firm was fitted with a patented thermostatic remote control with an illuminated dial, permitting adjustment of the bed temperature between about 90 and 130° F.

A domestic infra-red heater was displayed by Dimplex Limited, Millbrook, Southampton. Designed for the bathroom, kitchen, bedroom, and study, it incorporates an anodised aluminium reflector. The pressed-steel base plate is finished in various stove enamelled colours and the die-cast aluminium end caps are finished in black stove enamel. In addition, permanently oil-filled towel rails in loadings of 150 and 200 watt, were shown. These can be supplied for wall mounting only, for wall and floor mounting, or for floor mounting only.

On the stand of General Electric Company Limited, Magnet House, Kingsway, London, W.C.2, a portable or wall mounting fan heater was shown. It has a friction device that allows the heater to be adjusted to any convenient angle. Two 1 kilowatt separately switched elements operate at black heat and an automatic thermal cut-out is incorporated.

The Revo Roto-iron was shown by Revo Electric Limited, Tipton, Staffordshire. It is portable and can be used on an ordinary table so that the operator can sit down to work. Thermostatic control is incorporated and a control lever gives three alternatives: " off," " pressing," and " rolling." The roller is 21 in long and 5·25 in diameter, and will accommodate most types of laundered article.

A new design of rectangular wall mounting cistern heater was shown by Santon Limited, Somerton Works, Newport, Monmouthshire. It is available in capacities of 5, 7·5, 12, 15, and 20 gallons and, incorporating its own ball valve tank, is suitable for connecting directly to town water supply mains and for supplying water to two or more points.

Several new lamps were exhibited by Siemens Edison Swan Limited, 155 Charing Cross Road, London, W.C.2. A 12 volt double-filament automobile headlamp bulb embodying a shield fitted over one element has been introduced. The rating is 50/40 watt and the shield minimises dazzle. Also shown was the A1/176, a 500 watt miniature projector lamp enclosed in a 30 mm envelope and designed to operate at mains voltages. It is the latest addition to the existing range of lamps for small slide projectors, and was shown together with a recently developed 1,000 watt MEX/D xenon discharge lamp with a peak arc luminance of 20,000 stilbs.

Models of two low-temperature radiant warming systems, suitable for " off-peak " operation, were shown by Panelec (Great Britain) Limited, 21 Bloomsbury Street, London, W.C.1. The first model showed the Panelec re-wirable system, which has twin-core Bestos-insulated, lead-sheathed heating cables drawn into cable housings. The housings are shaped to provide rapid diffusion of heat through expanded metal into the surrounding concrete. It is possible to fill the access trough covers with screed, and surface finish them to match the surrounding floor area.

The other model was an embedded system using p.v.c. insulated heating cables. The heating cables, which are supplied with 12 ft long cold tails and factory made joints, are fixed at the required distance apart in a plastics T-section cable grip.

THERMAL STORAGE HEATERS ON TRIAL

To explore the practicability of thermal storage block heaters, the utilisation research committee of the Electricity Council are to experiment with 12 houses now under construction, in the Leicester area. The houses will be equipped with electric cookers and water heaters—the latter on off-peak supply—and with block heaters in the living room, kitchen, and hall. Electric fires with coal-imitation effects will be installed in the living room for supplementary heating. Four houses will have improved insulation by means of Fibreglass in the wall cavities and double glazing in the living room.

For each tenant, the consumption of the block heaters and of the supplementary space heater will be metered separately. Provision will be made for continuous load recording and thermocouples installed in all living rooms, kitchens, halls, and main bedrooms will enable temperatures to be continuously recorded.

When thermal storage block heaters were first put on the market in their present shape, it was felt that they would not be suitable for domestic heating. However, they do offer a means whereby the load factor of existing houses can be improved.

HOT PLATE

A new range of hot plates, called the " Vee-line," is being produced by the English Electric Company Limited, Marconi House, London, W.C.2. The sheath element has a triangular cross-section, and it is connected to the terminal box by a patent swivel mount. The latter allows the element to pivot clear of the support and spillage tray, so that the plate and reflector can be cleaned. Greater heat transfer and a more robust construction are claimed to result from the new element shape. The plates are being made under licence from Tuttle and Kift Incorporated, Chicago, U.S.A.

The plates, which are available in 8 in and 6·25 in diameter sizes, conform to the EDA interchangeability specification. Both single and double circuit patterns will be made, for control by simmer or three-heat switches.

The element consists of a double spiral of 80/20 nickel-chromium alloy embedded in magnesium oxide contained in a sheath of Iconel tubing. The sheath is sealed at the inner end. During manufacture, the element tube is compressed to its triangular shape, the heating spirals being sited at corners of the triangle.

The reflector is a deep pressing of heavy-gauge polished aluminium, to allow spillage to drain away clear of the element. Separate from the element, the stainless-steel support slots into the reflector, is three-armed, and holds the element in position without restricting expansion or contraction.

A drip-proof collar connects the element to the vitreous enamelled terminal box. Stranded nickel wires, insulated with a flexible sleeving of braided glass and silicone rubber, connect the element to the plug pins, which fit standard EDA sockets. Two loadings are available. The 8 in plate (model 2870) has 2·1 kW loading; the 6 in plate (model 2880), 1·25 kW.

The triangular cross-sectioned coil swings upright for cleaning.

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